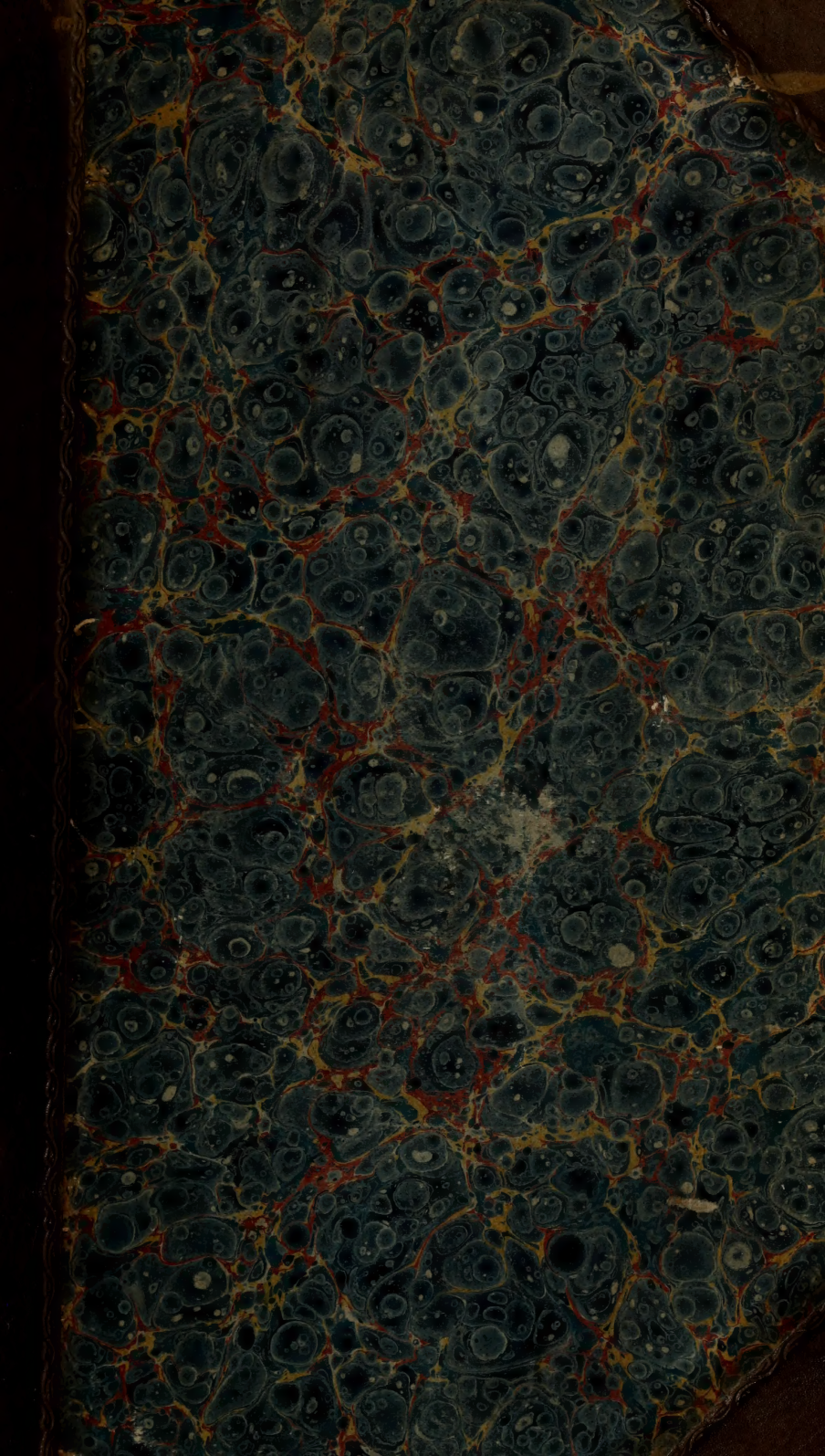






THE
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THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE
PROGRESSIVE DISCOVERIES AND IMPROVEMENTS
IN THE
SCIENCES AND THE ARTS.



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THE
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On the Phenomena of the Scratched Rock Surfaces. By THEODORE KJERULF; *with a Notice of the Post-Pliocene Fossils of Southern Norway.* By Dr SARS, Professor of Natural History, Christiania.*

[The following paper on the Boulder-clay of Norway, by the well-known Norwegian geologist, Kjerulf, is presented to our readers as likely to be interesting and instructive to the many students of this difficult subject, who may not have access to it in the original Norwegian.

The translator thinks it proper to mention that he has not adhered slavishly to the original text, having thrown two papers of Mr Kjerulf into one, and having omitted all that was of merely local interest. The second diagram here given is not strictly the same as any one of the many supplied by Mr Kjerulf, but is an attempt to reproduce in small compass all the essential features to be gathered from the whole of these. The most important alteration which it presents is the introduction of the small heap of boulder clay, underlying the marl, in a somewhat more distinct shape than it bears in the original diagram. This change is, however, justified, not only in part, by the particular diagram referred to, but still more by many statements in the text, more especially in some of those more local descriptions which have been omitted. In all cases the translator has endeavoured to

* Translated from the Danish, for the Edinburgh New Philosophical Journal, by the Rev. R. Boog Watson, F.R.S.E.

reproduce, if not the very words, for which space was often wanting, yet at least always, and strictly, the views expressed by Mr Kjerulf; and wherever he has felt that the responsibility of a statement or an inference rested with himself, he has put it in the form of a note.—*Translator.*]

It is well known that the surface of our mountains is in many places scoured, polished, striated, and bared, and that at times to a height of 4000 or even 5000 feet above the sea. All over the country such surfaces may be seen; for as the country is covered with mountains, so are the mountains with scratches. These had attracted the attention of scientific miners in Sweden, but Sefström was the first to study them carefully. He remarked that the striæ followed a determinate direction, and bore a relation to the course in which the boulders of the country had travelled. Thus the furrows follow a southerly direction; and in like manner the porphyry blocks of Elfdal have been carried south to Landskab, where they now lie among totally different formations. Hence he inferred that the direction pervading the entire phenomenon was one from north to south. He believed that the agent in all this was a flood—a vast mass of boulders, stones, debris, and sand swept away by water, which had poured across the mountains with incredible rapidity and force, sufficient to make the large stones slide over the surface of the mountains and scratch these, as a grain of sand will do when made to grate along under the finger over a marble slab; while the smaller masses were ground against each other, and left piled up in the long backed Åsar of Sweden, the Raer of our Smaalehn district.

Sefström's paper is found in the Kongl. Vetenskaps Akad. Handl., 1836.

Hoffmann, Pusch, and Böhlingk, suggested a different direction for the phenomena. They showed that the erratic blocks are distributed over the flat of Northern Europe in a great circle, of which Scandinavia and Finland form the centre—that in Northern Russia, the blocks are Finnish; in Poland, are mixed with Swedish; in the Netherlands and North Germany, are Norwegian and Swedish—that beyond these limits the blocks have not travelled—and that

in Finland, at the White Sea, and on the northern glacial ocean, the striation radiates outwards.

If, then, there was a stream, it was not moving in any *one* direction alone, but must have had, in addition, an outward lateral motion along the axis of its general course; and the question arose whether the motion was from one centre or from several. The utmost attention was now directed to the striations in various localities, and hundreds of observations were collected; blocks were carefully tracked back to their original site, the weather or exposed, and the lee side of rocks were attentively noted, and the materials accumulated became enormous. These were tabulated on maps by Hörbye and Rördam in 1857, &c.

As to the direction of the scratches, there can be now no doubt; but till this was ascertained, the question whence and whether the grinding down proceeded could only be determined from the somewhat doubtful indications of the "weather and lee sides" and the boulders. Now, however, if we examine the maps, we shall observe spots from which the arrow markings radiate out in different directions. Such spots must have been the centres of motion, and they lie, it will be found, in the higher districts of our mountains; or where, at a lower level, they occur in the form of cross scratches, they may indicate the successive application of friction in slightly different directions.

Thus far, then, we have got; the phenomenon itself is no fiction, however erroneous may be the explanation of it by a flood. Innumerable observations with the compass have shown that the scratches and striations are there, that there must further have been various centres whence the phenomena originated, and finally, that in some places at least, the force has operated again and again.

When now we consider that glacier ice, with the debris which it carries along with it, produces striations on the surface of the rocks over which it is ever, though slowly, advancing; when we consider, further, that a glacier moves boulders either involved in the debris of the end and side moraines, or in the form of huge, scattered, sharp-angled blocks, which in one way or other have reached the surface of the glacier, and now share in its movements, we may

infer that we have obtained the key to all the phenomena of friction which we have to explain. The comparatively small scale of the glacier phenomena with which we are acquainted, leaves, indeed, many difficulties in our way; but here, fortunately, we meet with Mr Rink's valuable observations, prosecuted during the many years of his stay on the west coast of Greenland, of glacier action in that country. From his descriptions, it is obvious that here, as in our own land, we have an enormous stretch of country; that this country is completely covered with ice, which, on the west coast, is ever slowly pressing outwards to the sea, where it "calves;" that immense loads of these ice "calves" are every year floated away by currents in the same constant direction; and finally, that this ice-cake attains a thickness of no less than 1000 feet.

Here, then, all the conditions of our problem are provided for. Let us figure to ourselves a universal ice covering, a complete glaciation instead of mere individual glaciers, and the phenomenon of friction takes its place harmoniously with all the other phenomena of the glacial epoch. In the existing state of Greenland is the very analogy we needed to justify our supposition—a gigantic cake of ice slowly moving outwards, and with the might of its tremendous pressure, stripping, polishing, and striating the rocks over which it glides, just like a common glacier, only in so much greater a proportion as the ice-cake of Greenland surpasses any glacier of Switzerland.

I shall endeavour to show that, in explaining the phenomena of friction, we know of no better agent than the ice-cake.

In respect of the direction of the scratches inferences have been drawn, (1.) From the boulders or erratic blocks. (2.) From the so-called "lee and weather sides." All the arrows on the striation maps have been laid down on the supposition that the blocks were moved by the same stream which was striating the rocks, and that all this tallies with the lee and weather sides which present themselves to our notice. Now, here it is important to observe,

1. That the boulders in the lower districts do *not* indicate the direction either whence or whither of the friction.

The boulders which we usually call erratic—great, generally sharp-cornered blocks which easily catch the eye—have doubtless been moved, but not always by the same “stream” which scratched. There is here a confounding of quite different things. These blocks in the lower districts lie on the top of the boulder-clay banks. How could it, then, be they that scratched the rocks. But it is precisely the erratic rocks which most catch the eye, lying as they do on the surface, large in size, sharp at their edges, and easily recognised. On the other hand who has ever broken his hammer on the true ‘scratchers,’—the stones great and small—crushed, rubbed, rounded, and broken—that lie at the bottom of the boulder-clay banks,—these heaps of debris which rest immediately on the rock?

Things are somewhat different in the higher districts. There one may, indeed, more safely draw inferences from the erratic blocks; but there, what with the vastness of the field and the fewness of the observers, we know too little of the minute lithology to entitle us to assert that any particular foreign block we may meet can only have proceeded from one special bed. If we could do this, we could indeed determine the direction of the moving power; but this we cannot do. Further, the blocks have been moved in various ways, and they cannot therefore be depended on for indicating how the arrows showing direction of motion should be laid down in the maps.

2. There has been too much of rash talking about lee and weather sides. In some cases such phenomena really exist; but such cases are rare; and generally the gentle slope on one side, and the steep break on the other, which have been described as instances of lee and weather sides, arise simply from the constitution and position of the rock itself. The mountains of Eggedal, for instance, all seem to show fine examples of a weather side towards the north, and a lee side towards the south, but this arises merely from the lie of the schist strata which dip to the north. Similarly, the porphyry hillocks in Asker and Barum seem to have weather sides to the north and lee sides to the south; but the cause of this is, that the porphyry beds dip north conformably with the underlying sandstone. When we are told, therefore, that the observer

has remarked fine examples of weather sides at a distance, we have good ground for distrusting his conclusions.

3. As to the marking of the arrows on the maps they often convey a false impression. The striations do indeed run towards valleys, and in a general way follow the lines of the valleys; but even the mountain plateaus have their valleys, which do not appear in maps of the small scale ordinarily used; were these marked, we should at once see that the friction has followed the valleys.

4. Finally, there is this to be laid down as a first principle, that the mere study of the phenomena and direction by compass of the scratches, and of the often quite independent boulders, is not sufficient to determine whether the agent which produced them was a stream or a glacier. Brogniart has called the striations the wheel-ruts of the phenomenon; but we have kept too much to the ruts, and forgotten the carriage and team. The loose masses, which owed their presence to this phenomenon, have passed unobserved. It is these we must study, if we are to understand the phenomena of friction; and it is as a name for these, the clay-sand and masses of debris connected with the phenomena of friction, that the term, "the Glacial Formation" has been introduced. And in fact there is more to be learned from the study of a single example of the glacial phenomena, in which all the various members of the formation are exhibited, than from thousands of scratches traced by the compass.

I proceed, therefore, to examine the glacial formation in detail as it presents itself in the district around Christiania.

The glacial formation includes masses of debris, blocks of stone, varieties of clay, and layers of sand. The term glacial is applied to it, partly because the oldest fossil shells found in it are of arctic species, and partly because the debris, the scratched rock surfaces and the boulders, connected as these are together, indicate that when they were produced the whole country was covered with ice. The entire formation may be divided into an earlier and a later group, of which the earlier alone is strictly glacial; but since the material of which the later group is composed was also originally glacial, and since the two groups are

very closely connected with one another, the name of the Glacial Formation may, for shortness sake, be applied to both.

The older and strictly glacial group consists of, 1. Glacial banks and debris heaps. 2. Glacial sand and marly clay, with the oldest glacial shell-beds. The later and post-glacial group consists of, 1. Shell-clay and shell-bearing sand—the later post-glacial shell-beds. 2. Brick-clay and inland clay. 3. Sandy clay and flood sand.

Following these is a third group of still later alluviums, river deltas, peat mosses, and river sand and gravel, all going on at the present day.

I. First, then, as to the older and strictly glacial group. (1.) The first part of this which we have to consider is the glacial banks. They consist of sand mixed with clay or with debris in general (*aur*), blocks, and the so-called rolled stones, which, however, are not rolled but scratched stones. Fragments of the most varied rocks are here mixed together. The position of these heaps of sand debris and blocks is always immediately on the furrowed rock surface itself. These banks are present everywhere, and everywhere are composed of the same heterogeneous materials. On the hills, at an elevation of 600 or 700 feet above the sea, this is the only formation present. At the lower levels it only appears in banks (*Åsar*, in Swedish; *Raer*, in Norwegian; *Kaims*, in Scotch) which rise amidst flat expanses of clay and sand, or sometimes appear in detached hillocks. In this form, which belongs to these banks in the lower districts, they rise to a level above the sea of from 6 to 700 feet. Such lower level glacial banks either stretch in long-backed ridges, which project markedly above the clay and sand flats, or lie completely buried in the interior of elevated sand plateaus, where their form and extension can in general only be inferred from the position of small lakes in their bendings, or from the curves which rivers and brooks, unable to cut through them, are compelled to follow. But the higher level banks, those, that is to say, which are found in the upper parts of the valleys and on the mountain slopes, rise to all elevations, even to a great height, sometimes fring-

ing the valleys as great heaps of debris, sometimes stretching right across, directly transverse to the course of the stream.

All these masses were originally true moraines.

It seldom happens that a good section of these banks can be seen; but as a rule they consist of debris (*aur*), with sand, clay, small and large stones, all irregularly heaped together without any trace of stratification. They rest directly on the surface of the rock, and are obviously the oldest of all the superficial deposits.

Besides such masses as have been now described, and which really deserve the name of banks, smaller heaps of debris and blocks exist, generally lying covered up and hidden, or protected by some projection of the rocks. Their origin and composition is exactly the same as those of the banks, from which they differ only in being less likely to attract notice. These are the glacial debris heaps.

(2.) There are also found in some places, resting immediately on the scratched surface of the rock, thin alternating layers of sand and clay. The sand is chiefly reddish and brown in colour, and sometimes preponderates decidedly over the clay. The sand and clay are occasionally twenty-five feet thick. Accumulations of big stones are at times found at the bottom of this deposit, in places where the form of the ground had afforded them shelter. Such stones are also scattered irregularly through the bed. This marly clay was formed from the destruction of Silurian limestones and schists. It was in all probability carried down by muddy rivers from the inland ice, and deposited as mud wherever the sea presented the necessary conditions of stillness. Freshly dug, this clay is always damp, often dripping with water. Its colour is bluish, seldom brown. Traces of a thin leafy or stratified structure may often be seen. Lime is pretty uniformly present to the extent of about two per cent. Exposed to the air this marly clay disintegrates more or less, but gets baked together again by rain. Its presence may generally be recognised by the thick clumps of the *tussilago* which it bears.

Balls or knots so round as almost to seem artificial are found in this marl, and have been considered as concretions

produced by the presence of a larger quantity of lime than usual ; but they are much more probably fragments of the Silurian limestones, rubbed and worn to their present shape during the ice period, by the same agency as broke and scoured and polished and crushed and rubbed all the surface of our rocks, and so prepared the stores of debris that form our boulder-clay. Such rounded lumps or balls are the distinctive characteristic by which to recognise this marl.

The marl often contains also extremely thin and small scales of mica, which glitter in the sun,—a proof how slowly this marly clay was deposited, and how still the water in which it was allowed to sink. It was only when they came to rest in the bosom of the deep and quiet ocean that the mud-laden waters which poured from the inland ice could part with their burden ; and in harmony with this we find, that the maximum height at which this marl is found is 450 feet above the present sea-level, a height which, as we shall see, corresponds exactly with that of the older marine shell-beds—[both facts thus pointing to the same conclusion,—the greater elevation of the sea in the later part of the glacial period, while our present boulder-clays were being formed in the interior of the land, and deposited along the shores and in the neighbouring shallows of the glacial ocean.—*Translator.*]

Where this marl is absent, the reason will be found to be the absence from the neighbourhood of such Silurian rocks as alone supply the materials from which it is formed.

As has been already mentioned, the marl sometimes interchanges endlessly with thinner or thicker layers of glacial sand, and wherever it does not rest directly on the scratched rock below, it is only separated by glacial sand or debris.

In general, no shells are found in the marly clay, the ice-cold fresh glacier water from which it was deposited being unfavourable to molluscan life, which would only develop itself in the salt water of the greater depths, or where at least the fresh water was largely mingled with the sea.—[These localities are still probably hidden from us below the present sea-level. We have, perhaps, instances of them in the Elie bank (p. 27), and the Dröbak bank (p. 25).—*Translator.*]

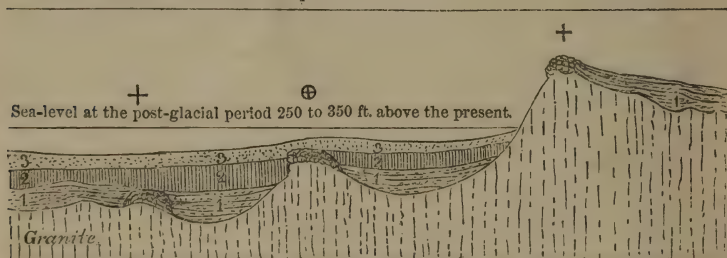
The few shells I have met with in the marl, or in the contemporary glacial sand, have been ascertained by Professor Sars to be either strictly arctic species, or marked by size and other peculiarities, with a distinctively arctic character.

Shell-beds, however, are found, which, though not actually in the marl, are yet closely connected with it, both in the strictly glacial character of their shells, and in the range above the sea-level to which they ascend. These beds are loose heaps of entire and broken shells, sometimes without the addition of any other substances, sometimes mixed with sand and sandy clay. They are, in fact, true littoral banks.

These shell-beds must not be confounded with the later shell-beds. The latter belong to the post-glacial period, when the sea stood at a lower elevation than before. The true glacial shell-beds, of which we are now speaking, lie at a level of from 400 to 470 feet, and belong to that earlier period, when the land was depressed not less than 500 or 600 feet below the present level of the sea. They are probably contemporaneous, or nearly so, with the glacial banks formerly described, and with the sands and marls which have been mentioned as resting directly on the furrowed surface of the underlying rock.

The accompanying diagram may make this more intelligible.

Old sea-level about 600 feet above the present.



Present sea-level.

Fig. 1.

At the bottom is granite; above this is (1.) Sand and marl, associated with the cotemporary shell beds marked +; (2.) Are the later clays; (3.) Sand. The sand and marl marked (1.), and the shell beds +, belong to the earlier glacial period, during the latter part of which the sea-level

stood at least 600 feet higher than at present. Any shells of this period, at the lower levels, will be found deeply buried under later deposits, while at the higher levels they lie exposed.

(2.) and (3.) The clays and sands, and their accompanying shell-bed marked $\oplus$ belong to the later period, when the sea-level had fallen 400 feet. The higher levels being by this elevation of the land protruded above the sea, the shell-beds already found on them were preserved from being buried under later deposits. None of the *later* shell-beds are therefore to be found at this elevation, but they present themselves at the lower levels, at or near the surface, among the later clays and sands.

II. We now come to the second or post-glacial group of deposits,—(1.) The first member of which is the later shell-clay to which we adverted above. Like the marl, it is derived from disintegrated Silurian strata, but more especially from the clay schists of that age. When freshly dug out, it is generally of a bluish-grey colour, and less wet than the marl. It has been deposited in salt water, and very often contains well-preserved shells of the same species as are still living on our coasts. In position it is superior to the marl and glacial sand; but it does not rise to so high a level above the sea as these, its maximum height being about 350 feet. In general, it does not ascend above 250 or 270 feet. This shell-clay is sometimes, though not always, mixed with lime. It is frequently worked for bricks.

(2.) The brick-clay in the *marine* beds is identical with the *inland* clays of the higher levels, from which it only differs in the greater thickness and purity of the banks in which it presents itself. It is generally blue or brown in colour, and these shades sometimes alternate in clods or stripes. No shells are found in the brick-clay.

In the course of the valleys this clay is found at all elevations deposited in old lake basins; it disappears, however, in proportion as we advance into the quartzose districts. Above the old sea-level it is very often mixed with sand, and contains layers, more or less thick, of fine sand. Since even at the lower levels it contains no shells, we must infer

that it has been deposited from streams of fresh water. It overlies the shell-clay.

(3.) Sandy clay and stratified flood sand, which alternate with another. The clay is generally light-grey in colour, and more or less mixed with fine sand, in consequence of which it is less plastic, and when dry does not stick to the tongue. The transition from sandy clay to clayey sand is sometimes complete. The sand is brown or grey, and the beds vary much in thickness. Here and there large gatherings of boulder stones may be found in it, especially towards the top.

The source whence this sandy clay and river sand were derived is the old glacial banks of the boulder-clay. It was from these banks that the sands and clays were washed, and the finer the particles the greater the distance to which they were removed. Hence the sand generally lies nearest the boulder-clay banks, while the sandy clay rests further off. Hence, also, we find sandy plateaus so constantly associated with the boulder-clay banks at the lower levels; for there these banks have uniformly been reached and washed by the sea when it stood at its former higher level. In Southern Norway, however, it must be remarked, that the distribution of the sand is especially to the south of the banks, a fact which seems to indicate the influence of fresh-water currents pouring out seaward from the land on the north.

No shells are found in this sandy clay or river sand, which overlie the previously mentioned clays, Nos. (1) and (2). The height to which they rise is, at the lower levels, largely dependent on the original height of the nearest boulder-clay banks. Thus, in the more open country, they have been traced to elevations of from 400 to 600 feet. Up the river courses again they rise to any elevation, so long as the valley slopes exist, and the lake basins continue to present themselves.

The accompanying section shows the succession of the various beds. They rest on the underlying granite. On the surface of the granite, where an angle of the rock has afforded shelter, is a heap of boulder-clay with boulders 1.*

* Such heaps of boulder-clay below the marl belong to the oldest part of the deposit, and are peculiarly interesting, as the only records of that earlier

Overlying this, but resting generally on the rock, is the marl 2 of No. I. division. To this succeeds the second division: 1. The shell-clay, &c.; 2. The brick-clay; 3. Sand

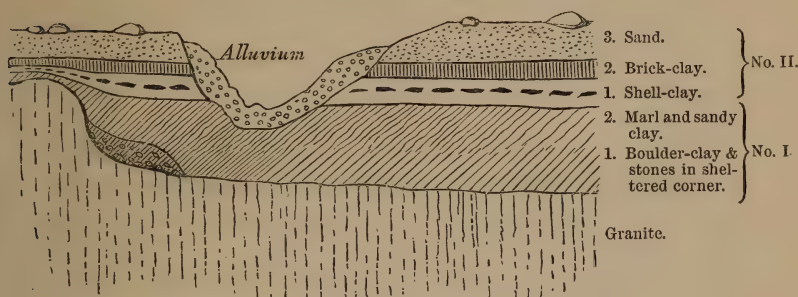


Fig. 2.

or sandy clay, on which large boulders rest loosely. Through these a valley has been cut, where, however, the section presented in its banks is as often obscured by alluvium.

A diminution of the glacial cold, and along with this a great thawing of the inland ice, seems to have occurred between the deposition of the marl with its associated shell-beds and the later shell-clay, for the more markedly arctic character of the Fauna is wanting in the latter clay. Hence the division of the beds into the glacial and the post-glacial groups.

This shell-clay was a regular marine formation, deposited in a perfectly orderly and quiet state of things; but after its formation there must have followed a time of floods, during which the many dams, forming basins and lakes in the valleys, were cut through, and the clay, the sand, the

period which we possess. They were formed at the same time that the rock surfaces in the lower districts were striated under the general covering of ice. The greatest mass of the boulder-clay, however, formed during that period, seems to have been either thrust into the sea and left at depths still below our reach, or so mixed up with the boulder-clay of a later period as to be undistinguishable from it. That our existing boulder-clays generally belong to a later period is obvious, since they are contemporary with the marls, which are a sea deposit, formed on the submerged land, which had previously been furrowed and scratched by the old ice-covering grinding over its surface, and leaving its detritus only in such places as were protected from the motion of the ice.—[Translator.]

debris and rolled stones of the interior, were washed further and further down. The striking absence of fossil shells in the brick-clay, and in the sandy clay and flood sand; the complete identity of the brick-clay and the inland fresh-water clays; the expansion of the plateaus of stratified sand around original banks,—all these strongly indicate such a flood period.

III. In regard to the third group (p. 7), consisting of alluvium, peat, and other fresh-water formations, it is unnecessary to say more, than that their extension at certain points indicates that the lakes to which they owe their origin formerly stood at a higher level than that which they now occupy.

From an examination then of the whole upper covering of our country, we learn that the older part of this formation has a markedly arctic character, and that the oldest masses of all are moraines. We are entitled, therefore, I think, to conceive of Norway, at the close of the Tertiary period, as being in a true glacial condition. Its ice covering had an outward movement like the present inland ice of Greenland. By this ice “rolled stones” and debris were borne outwards to the sea-shore, where large and small blocks of stone were floated off, and carried away on ice-floes. Hence originated those huge moraine masses (far too vast to have been produced by mere separate valley glaciers) which cover the whole of the flat land near the coast, and which may be traced on both sides of the Christiania Fjord. From this universal covering of moving land ice resulted the first great network of scorings and scratches, as well as the moraine masses extending out to the edge of the sea. Then followed a diminution of the glacial intensity. Instead of a continuous covering of ice, there were separate glaciers, which laboured down from the various mountain slopes into the open valleys at their feet. All the loose material which lay in their way they bore off as moraines, either along their sides or in front, or where two valleys converged as medial moraines. The process of striation thus went on anew in all these valleys; and in this way two

different sets of scratches, lying across one another, might sometimes be produced.

In our larger valleys we find masses of debris, stones, and sand, lying like long terraces along the one or the other side, sometimes along both. These are side moraines. Further down, nearer the mouth of the valleys, and also higher up, more among the mountains themselves, the same masses—banks of boulder-clay—lie right across the valleys. These are terminal moraines, left where the glaciers pushed out in the lower districts towards the coast, or higher up among the mountains, as the last glaciers shrunk and retreated.

The glaciation ceased by a gradual melting and disappearance of the ice. During this perhaps protracted period, the mud-laden glacier rivers were bearing down with them the detritus with which they were charged, depositing it in the sea or in inland lakes, wherever the water was sufficiently still to allow it to sink. Hence our marine and lake clays. Running water, too, acted on the moraines, washing out the sand from these masses of debris, and spreading it around and over them. Hence the stratified upper part of the banks and the sand spread far out over the clay around the old banks.

On the coast, where the sea received the matter thus brought down, shell-fish made their appearance, partly buried in the clay, partly in the form of entire beds. These beds are found up to a height of 500 feet. To this extent, therefore, the land must have stood at a lower elevation.

Let us now see in what order this glacial matter has been sorted and heaped up by the sea:—

At the bottom of all we find, except where they have been afterwards swept away, sand and rolled stones. These were the scratching agents. It was they which were dragged by the ice across the rock faces; and if we are to deduce from the blocks the direction of the friction, it is these blocks we must examine; but as they are most frequently broken, reduced in size, and often rounded, they are generally called not blocks but rolled stones, though the name is not strictly correct, and they should rather be called “scouring stones.” They have not been rolled, but have mutually

crushed one another, and, fixed in the ice like a diamond in a glazier's cutting-instrument, they have scored the hill side with scratches and furrows.

Over these "scouring stones" and sand lie the various clays:—Calcareous and marl clays, in such districts as presented Silurian limestones and schists to supply detritus to the glacier rivers. Above this, shell-clay, wherever the height was not too great, or the streams of cold fresh-water too powerful to admit of molluscan life. Then follows brick-clay without shells, belonging probably to the time when the flush of water from the land was at its height. Finally, sand and sandy clay above all.

Stones brought from a distance may be found here and there through all these layers; but most distinctively the erratic blocks are found lying stranded on the top of the banks. (See fig. 2, p. 13). All parties are agreed that ice was the agent which brought down these blocks.

When moraines had been left stretching across the valleys, they would often in the upper reaches become, during the time of the glacier's melting, a dam for an inland lake. The floating particles carried along by the river would be deposited in such quiet basins, and hence come those inland clays which lie at heights above that of the marine formation. In such lakes, just as in the sea below, ice-floes might drift about laden with small and large blocks, which thus became erratic. Even in the ice itself, far up in the interior, large temporary lakes might be formed when the ice was melting rapidly; and there blocks might be drifted on floes in a totally different direction from that in which the inland ice itself was moving and tracing its furrows. This may serve to explain how in some places the direction in which the erratic blocks have journeyed does not correspond with that of the scratchings.

Such phenomena, then, as we have been considering, could not be the work of a flood. A flood strong enough to furrow both hard and soft rock, and even to give their shape to the mountains, with their weather and lee sides—a flood of such incredible force could not have failed to sweep away before it all these loose masses of scratched stones and debris of sand and mud. Yet here we find them

set down, sometimes in the midst of a valley, sometimes along its edges, nay, sometimes stretching right across, with only a small opening cut through at one side, obviously by a stream quietly escaping from a lake. Nor can we see whence such a flood could come. The mountain tops would not supply it; nor would a sea wave in any form produce the regularity and uniformity of the phenomena, nor transport the boulders, nor trace the furrows.

Neither is Sir Charles Lyell's theory of floating icebergs much more satisfactory. Even were the striations such as icebergs could produce, which is not the case, some traces of the sea and its inhabitants would surely have been found on the higher levels, depressed beneath the sea, as the land, on this theory, was to the extent of 4000 feet at least; since to that height the scratching has been distinctly traced. Arctic shells are indeed found abundantly among our clays and sands, but never at a greater height than 600 feet above the sea.

Further, it must be remembered that oscillations of the land, of such frequency and extent as this theory imagines, are eminently improbable in Norway, where the entire series of the secondary and tertiary strata are wanting, and where, therefore, the land has been singularly stationary.

Shells from the Earlier and Later Beds of the Glacial Formation. By Dr M. SARS, Professor of Natural History, Christiania.

[The only beds here examined are in the southern part of Norway, and even of these the author states that the examination is far from complete. In explanation of the author's headings in the following list, it must be remembered that while the beds are to be found at all elevations from the sea-level to a height of 500 feet, yet at the lower levels (up to 200 feet) such shell-beds as present themselves on the surface belong to a later period; while the older beds must be sought either on the surface at the higher levels, or buried deep under the later clays and sands at the lower levels. But while this holds true in general, partial exceptions to the rule may be expected, as in the case mentioned

at p. 25, where a current has probably prevented the accumulation of later deposits.—*Translator.*]

Note.—The lists of shells are printed exactly as given by the author. Where his name is not the one received here, the translator has supplied the other with the mark *syn.*

HIGHER LYING (OLDEST) SHELL BEDS.

Killebo in Rakkestadt. Height 400 to 440 feet.

This bed rests partly on the solid rock, partly on an intervening bed of clay four or five feet thick.

Balanus porcatus, da Costa, Darw. *B. crenatus*, Brug., Darw.

Ochthosia Stroemii (Lepas), Müll., *syn.* *Verruca strömia*.

Serpula triquetra, L. *S. vermicularis*, Müll.

Trophon clathratus (Murex), L., *syn.* *Fusus banffius* var. *major*,

Loven. *Nassa reticulata* (Buccinum), L. *Natica nitida*,

Don. *Littorinalittorea* (Turbo), L. *L. littoralis* (Nerita), L.

Trochus tumidus, Mont. *T. magus*, L. *Puncturella noa-*

china (Patella), L. *Lepeta cæca* (Patella), Müll., *syn.* *Propili-*

dium ancyloide. *Pilidium fulvum* (Patella), Müll. *Anomia*

ephippium, L. *A. patelliformis*, L. *Ostrea edulis*, L.

Pecten islandicus, Müll. *Mytilus edulis*, L. *Modiola*

modiolus (Mytilus), L. *Cardium edule*, L. *Lucina borealis*

(Venus), L. *Venus ovata*, Penn. *Tapes pullastra* (Venus),

Mont. *Astarte arctica*, Gray. *A. compressa*, Mont. *A.*

elliptica, Brown. *Tellina proxima*, Brown. *Mya truncata*, L.

Saxicava pholadis (Mytilus), L., *syn.* *S. rugosa*. *S. arctica*

(Mya), L.

Skjældalen in Aremark. Height 470 feet.

On the rock rests a layer of clay of varying thickness, in which are shells. Above this is the shell-bed ten feet thick, in the midst of which occurs a bed of clay deposited from water.

Balanus porcatus, da Costa, Darw.

Trophon clathratus (Murex), L., var. *major* Lovén. *Buc-*

cinum undatum, L. *B. grönladicum*, Chemn. *Natica*

clausa, Sow. *Tapes pullastra* (Venus), Mont. *Tellina*

proxima, Brown. *Mya truncata*, L., et var. *Udewallensis*,

Forb. *Saxicava pholadis* (Mytilus), L., *syn.* *S. rugosa*.

(Five new species since found. Names not given.—*Translator.*)

Skullerud in Höland. Height 450 feet.

On the top is a layer of sand mixed with shells, below is a sandy clay with shells. At the bottom common sandy clay.

Balanus porcatus, da Costa, Darw.

Tritonium despectum (*Murex*), L., *syn.* *Fusus antiquus*. *Trophon clathratus* (*Murex*), L., var. *major* Lovén. *Buccinum grönlandicum*, Chemn. *Natica clausa*, Sow. *Pecten islandicus*, Müll. *Mytilus edulis*, L. *Tellina solidula*, L.

(Thirteen new species since found. Names not given.—*Translator.*)

Björum in Asker. Height 460 feet.

Tritonium despectum (*Murex*), L., *syn.* *Fusus antiquus*. *Buccinum undatum*, L. *Natica grönlandica*, Beck. *Aporrhais pes pelicani* (*Strombus*), L. *Littorina littorea* (*Turbo*), L. *Dentalium abyssorum*, Sars. *Pecten danicus*, Chemn. *Leda pernula* (*Arca*), Müll. *Cyprina islandica* (*Venus*), L. *Panopæa norvegica* (*Mya*), Spengl.

OLDEST CLAY UNDERLYING LATER DEPOSITS.

Brynd, near Christiania. Height 200 feet and upwards.

The shells occur in a sandy marl, with thin layers of sand interspersed.

Siphonodentalium vitreum, Sars. *Arca raridentata*, Wood, var. *major*, Sars. *Yoldia pygmæa* (*Nucula*), Münst.

Somewhat Higher.

Pecten danicus, Chemn.

Skibtvædt. Height 90 feet.

Close beside the church; on the very edge of the River Glommen, and pretty deep below the surface of the clay-flat; in beds of sand, which occur in clay beds.

Siphonodentalium vitreum, Sars. *Arca raridentata*, Wood, var. *major*, Sars. *Leda pernula* (*Arca*), Müll. *Pecten danicus*, Chemn.

Bakkehuus, near Christiania.

Nassa reticulata (*Buccinum*), L. *Cyprina islandica* (*Venus*), L. *Corbula nucleus*, Lamk.

Lekum in Edsberg. Height 220 feet.

Here the shell-beds are of small extent and thickness. They lie in the upper part of the clay flat which extends all around.

Littorina littorea (Turbo), L. *L. littoralis* (Nerita), L.
Mytilus edulis, L.

Grorud near Christiania.

In the sea-weed clay, which takes the place of the shell-clay.

Tellina solidula, L. *Saxicava pholadis* (*Mytilus*), L. *syn.* *S. rugosa*.

Glaeng and Sarpen. Height 80 to 100 feet.

Ostrea edulis, L. *Pecten danicus*, Chemn. *P. opercularis* (*Ostrea*), L. *Cardium echinatum*, L. *Cyprina islandica* (*Venus*) L., (often perforated by *Cliona celata*, Grant.)
Astarte compressa, Mont. *Tellina proxima*, Brown.

Kaholmen near Dröbak. Height 20 to 30 feet.

Lowest clay.

Tritonium despectum (*Murex*), L., *syn.* *Fusus antiquus*. *Pecten maximus*, L. *Lima excavata* (*Ostrea*), Gmel. *Cyprina islandica* (*Venus*) L.

Oculina prolifera (*Madrepora*) L. (also in a mass of clay 20–30 feet and upwards above the sea, south of Dröbak).

CLAY OF BOTH AGES, EARLIER AND LATER.

Lower and Upper Foss near Christiania.

Partly in the marl, interspersed with thin layers of sand ; partly in the overlying shell-clay.

Turritella communis, Risso. *Philine scabra* (*Bulla*), Müll.
Dentalium abyssorum, Sars. *D. entalis*, L. *Siphonodentalium vitreum*, Sars. *Ostrea edulis*, L. *Pecten islandicus*, Müll. *P. danicus*, Chemn. *P. tigrinus*, Müll. *P. sinuosus*, Turt. *Arca raridentata*, Wood, var. *major*, Sars. *Nucula tenuis* (*Arca*), Mont. *Leda caudata* (*Arca*), Don. *L. pernula* (*Arca*), Müll., *syn.* *L. oblonga*. *Yoldia pygmaea* (*Nucula*), Münst. *Cardium edule*, L. *C. suecicum*, Reeve. *Isocardia cor* (*Cardium*), L. *Syndosmya nitida* (*Mya*), Müll., *syn.* *S. intermedia*. *Corbula nucleus*, Lamk. *Saxicava arctica* (*Mya*), L.

(Eighteen new species since found. Those named are echinoderms; *Ophiura sarsii*, *Otenodiscus crispatus*, *Tripylus fragilis*, previously unknown in the glacial formation.—*Trans.*)

LATER SHELL-BEDS, BELONGING TO THE LOWER LEVELS.

Hövig near Christiania. Height 100 to 150 feet and upwards.

In sand, resting directly on the rock with clay around.

Tritonium despectum (Murex), L., *syn.* *Fusus antiquus*. *Nassa reticulata* (Buccinum), L. *Cerithium reticulatum*, da Costa. *Aporrhais pes pelicani* (Strombus), L. *Littorina littorea* (Turbo), L. *L. littoralis* (Nerita), L. *Rissoa membranacea* (Turbo), Ad. *syn.* *R. labiosa*. *Trochus cinerarius*, L. *Dentalium entalis*, L. *Ostrea edulis*, L. *Pecten varius* (Ostrea), L. *Nucula margaritacea*, Lamk., *syn.* *N. nucleus*. *Cardium fasciatum*, Mont. *C. pygmæum*, Don. *Tapes decussata* (Venus), L. *Astarte elliptica*, Brown. *A. compressa* (Venus), Mont. *Corbula nucleus*, Lamk. *Saxicava pholadis* (Mytilus), L., *syn.* *S. rugosa*. *S. arctica* (Mya), L.

Heistadt near Eidanger Fjord. Height 100 to 150 feet and upwards

In digging a well, shells found in the sand exactly as at Hövig.

Nassa reticulata (Buccinum), L. *Cerithium reticulatum*, da Costa. *Rissoa parva*, da Costa. *Emarginula reticulata*, Sow. *Acmæa virginea* (Patella), Müll. *Venus ovata*, Penn. *Lucina borealis* (Venus), L.

Ravnsborg near Christiania. Height 50 feet and upwards.

In sand resting directly on the rock.

Ostrea edulis, L. *Cardium echinatum*, L. *Astarte compressa* (Venus), Mont. *Lucina borealis* (Venus), L.

Aafoss near Skien. Height 100 feet and upwards.

At the bottom is sand and sandy clay, above this lies a bed of shells more than ten feet thick.

Balanus crenatus, Brug., Darw.

Buccinum undatum, L. *Purpura lapillus* (Buccinum), L. *Natica nitida*, Don. *Littorina littoralis* (Nerita), L. *Lacuna vineta* (Turbo), Mont. *Trochus cinerarius*, L. *Patella pellucida*, L. *Anomia patelliformis*, L. *A. aculeata*,

Müll. Pecten islandicus, Müll. Cardium fasciatum, Mont. Venus ovata, Penn. Tapes pullastra (Venus), Mont. Tellina proxima, Brown. Saxicava pholadis (Mytilus), L., *syn.* S. rugosa. Thracia villosiuscula, Macgill.

(Twenty-seven new species found. Names not given. Another bed found, about 30 feet lower, containing thirty-two species, all now living in the neighbourhood, among which are *Echinus dröbachiensis* and an *Echinocyamus angulosus*.—*Translator*.)

Löveidet near Skien. Height 120 feet and upwards.

Shell-bed rests on the rock.

Balanus porcatus, da Costa, Darw. B. crenatus, Brug., Darw. Buccinum undatum, L. Nassa incrassata (Buccinum), Ström. Natica nitida, Don. Velutina lævigata (Helix), L. Littorina littorea (Turbo), L. L. littoralis (Nerita), L. Patella vulgata, L. Acmaea virginea (Patella), Müll. Pilidium fulvum (Patella), Müll. Dentalium abyssorum, Sars. Anomia ephippium, L. A. patelliformis, L. Pecten islandicus, Müll. P. striatus, Müll. P. danicus, Chemn. P. tigrinus, Müll. P. sinuosus, Turt., *syn.* P. pusio. Mytilus edulis, L. Leda pernula (Arca), Müll. Venus striatula, Don. V. Ovata, Penn. Tapes pullastra (Venus), Mont. Astarte sulcata, da Costa. A. compressa, Mont. Mactra elliptica, Brown. Tellina proxima, Brown. Mya arenaria, L. Thracia villosiuscula, Macgill. Pholas candida, L.

Echinus dröbachiensis, Müll.

Ommedalsstrand near Skien. Height 100 feet and upwards.

Sandy clay, and fine sand mixed with shell fragments, in all some 50 feet thick.

Balanus porcatus, da Costa, Darw. B. crenatus. Brug., Darw. Serpula triquetra, L. S. polita, Sars.

Buccinum undatum, L. Nassa incrassata (Buccinum), Ström. Natica nitida, Don. Velutina lævigata (Helix), L. Littorina littorea (Turbo), L. L. littoralis (Nerita), L. Rissoa parva, da Costa = v. R. interr. R. striata (Turbo) Ad. Emarginula reticulata, Sow. Capulus hungaricus (Patella), L. Patella vulgata, L. Acmaea virginea (Patella), Müll. Pilidium fulvum (Patella), Müll. Dentalium abyssorum, Sars. Anomia ephippium, L. A. patelliformis, L. Pecten islandicus, Müll. P. danicus, Chemn. P. tigrinus, Müll. P. striatus, Müll. P. sinuosus,

Turt., *syn.* *P. pusio*. *Mytilus edulis*, L. *Nucula margaritacea*, Lamk., *syn.* *N. nucleus*. *Leda pernula* (Arca), Müll., *syn.* *L. oblonga*. *Cardium echinatum*, L. *Lucina borealis* (Venus), L. *Cyprina islandica* (Venus), L. *Venus ovata*, Penn. *V. striatula*, Don. *Astarte sulcata*, da Costa. *A. compressa*, Mont. *Mactra elliptica*, Brown. *Syndosmya alba* (*Mactra*), Wood. *Solen ensis*, L. *Saxicava pholadis* (*Mytilus*), L., *syn.* *S. rugosa*. *Cochlodesma prætenue* (Mya), Pult. *Pholas crispata*, L. *P. candida*, L. *Waldheimia cranium* (*Terebrat*), Müll.
Echinus dröbachiensis, Müll. *E. esculentus*, Linn.

(Twenty-one new species found. Names not given.—*Trans.*)

Remarks—

1. *Tritonium despectum* (*Murex*), L., *syn.* *Fusus antiquus* E. Forbes.—Distinctively arctic; common in extreme north of Norway, Russia, Greenland; very rare and small at Christiansund; Lat. 63°10'.

2. *Trophon clathratus*, L., *syn.* *Fusus banffius*, E. Forbes.—Arctic and circumpolar; diminishes in size as it goes south as far as Ireland. In north of Norway from 12 to 15^{mm}. in length, Greenland 24^{mm}, Spitzbergen 32^{mm}. Fossil, frequent; 40^{mm}. in length.

3. *Buccinum grœlandicum*, Chemn.—Arctic and circumpolar; frequent in Finmark, but not further south, size there 53^{mm}.; fossil, very frequent, and up to 67^{mm}. in length.

4. *Natica clausa*, Sow.—Arctic and circumpolar, size there 26^{mm}.; common in Finmark up to 20^{mm}.; south as far as Bergen, but dwarfed and rare, 4 to 5^{mm}.; fossil, frequent and full sized, up to 30^{mm}. in length.

5. *Natica grœlandica*, Beck., *syn.* *N. pusilla*.—Arctic and circumpolar; common in north of Norway, becoming rarer and smaller towards the south, reaching the coast of Britain; fossil differs slightly from the common living *Natica grœlandica*, but approaches the form of the full-grown specimens of these.

6. *Trochus magus*, L.—Canaries and Mediterranean, and north as far as Shetland; not living in Norway; fossil, one specimen, agrees exactly with living species.

7. *Siphonodentalium vitreum*, Sars.—Only found in Finmark, north coast of Norway; rare; fossil pretty frequent in the oldest beds. This fact, and its present rarity, seem to indicate that it is dying out.

8. *Pecten islandicus*, Müll.—Distinctively Arctic; found on north coast of Norway and Russia, Greenland and east coast of America; goes south as far as the Christiania fjord and Bohuslän, but does not reach Britain; diminishes in frequency and size as it comes south; fossil frequent, agrees in size with the northern specimens.

9. *Lima excavata* (*ostræa*), J. C. Fabr.—A large species, well known on our west coast, and probably to be reckoned as Arctic, though found to the south as far as Bohuslän; it lives only in the region of the deep-sea corals, at from 150 to 300 fathoms; fossil, in the lowest clay, also found amongst the innumerable dead masses of *Oculina prolifera* (which see, p. 25), at a depth below the sea of from 10 to 15 fathoms on the Dröbak bank, which must therefore have been elevated at least 135 fathoms, or 800 feet.

10. *Arca raridentata*, Wood. — *Pectunculoides*, Scacchi.—Common along our whole coast; extends south to Gibraltar and even to the Ægean Sea, but in the far north attains a much larger size than to the south, and may therefore be considered as arctic; varies very much in form, both in length and depth, and in the projection of its umbo. The hinge teeth increase in number with age. It is both in its living and fossil state covered with a *hairy* membrane, though Forbes and Hanley state the contrary. Fossil, it is very frequent in the lowest clay, where the shells are found in pairs. It is so much larger than, and different from, the living specimens, as at first to appear specifically distinct, but the transitions between the two prove their identity. The great projection backwards of the ventral margin, and the great number of cardinal teeth—two respects in which the difference between the fossil and the living form is most marked—appear to be merely the effects of age and growth. It is a curious fact, that this species, which extends back into the newer Pliocene of Apulia and Sicily, and the Coralline Crag of England, appears there in the smaller form which it bears in its more southern habitats at the

present day, while the Post-pliocene specimens of the species, the descendants of the small Pliocene race, and the ancestors of the small living race, excel them both in size in the proportion of three to one.

11. *Astarte arctica*, Gray.—Arctic and circumpolar; extends south as far as Bergen, but is there exceedingly rare; does not reach Britain. (It is *very* rare in Britain, see Forbes and Hanley.—*Translator*.)

12. *Tapes decussata* (Venus), L.—A Mediterranean species; extends to England, on the south coast of which it is common, in Wales and Northumberland very scarce; not found further north. (Forbes and Hanley speak of it as *very* rare in north Britain, but as found buried in gravel in Skye and Shetland.—*Translator*.) Fossil, found in the later shell-beds of the lower levels, and is as large as the largest Mediterranean living specimens.

13. *Panopæa norvegica* (Mya.), Spengler.—Arctic and circumpolar; extends to the Cattegat and England, but there, as on our own coast, is exceedingly rare. Fossil, much more frequent than in the living state.

14. *Pholas candida*, L.—Extends from the Mediterranean to Scotland, and perhaps Norway. Fossil, frequent in the later shell-beds of the lower levels.

15. *Oculina prolifera* (Madrepora) L.; *Lophella prolifera*, Edw. and Haime.—This coral is found on our western and northern coast, at the vast depth of from 150 to 300 fathoms,—never less than this,—and forms pretty large bush-shaped masses of 2 feet in diameter. Fossil, it is found in the lowest clay, and also in vast quantities on the shoal which lies out in the Fjord to the west of Dröbak, and which has been already stated to be from 10 to 15 fathoms (60 to 90 feet) deep. It cannot have been washed thither by a stream or tide, for it is firmly attached to the solid rock just as it grew; of course, however, it is dead, and stripped bare of the formative polyp which could not survive the increased temperature of the shallower sea. We have thus the best possible proof of an elevation of the land in this upheaval of a portion of the sea-bottom, and that to the extent of at least 135 fathoms, or 800 feet; and with this evidence it is interesting further to compare

the fact of *Balanus* shells being found on the solid rock by Brogniart at Udevalla, 200 feet above the sea; by Lyell 14 miles north of Kured 100 feet above the sea; and by Keilhau near Hellesaa, in Aremark, 450 feet above the sea.

The above sketch is very imperfect, scarcely any of the places mentioned having been satisfactorily examined by any zoologist; hitherto it has been geologists alone who have paid any attention to the subject, and they, occupied with many other matters, have given little time to the laborious task of collecting the numerous species which exist.

On such imperfect data, therefore, it would be rash to generalise; one or two inferences are however obvious.

1. We are assured that we are really dealing with Post-pliocene formations, since all the organic remains which have been found belong without exception to living species.

2. The fossiliferous strata of this period are distinguishable into two classes. The first class, both from stratigraphical position and organic contents, is obviously older. It includes those masses of shells which ascend to 470 feet above the level of the sea, and the deepest situated clay, which rises to a height of 240 feet above the sea. The second class belongs to a later period, and consists of the lower lying shell-beds, which rise to a height of 200 feet above the sea, and the surface clays, which rise to 350 feet above the sea.

3. Among the fossil species of the older beds there are some which no longer inhabit our southern coast, but have their true habitat on the north coast of Norway, and some or all of the other arctic coasts. Such are *Tritonium despectum* (which, however, appears also in the later beds), *Buccinum islandicum*, *Natica clausa*, *Siphonodentalium vitreum*, *Astarte arctica*.

4. Other species also present in the older beds are more frequent, and generally larger than those of the same species now inhabiting our southern coasts, and specimens rivalling the fossils in frequency and in size must be sought in the far north. Such are *Trophon clathratus*, *Natica grænländica*, *Pecten islandicus* (which is also found in the later beds), *Lima excavata*, *Arca raridentata*, *Panopæa norvegica*.

5. Those in the later beds, on the contrary, with few

exceptions, agree perfectly with those now inhabiting our southern coasts.

6. From the fossil species we may infer that in the earlier post pliocene period a more northern fauna occupied our southern coasts than now prevails there; in other words, such a fauna as now exists only in the arctic zone. On the other hand, in the later period indicated by the newer beds, the arctic species gradually retired to the far north, and were replaced by the more southern forms, which now constitute so large a part of our marine fauna.

Loven, in his "Öfversigt af Ventensk. Akad. Forh., 1846," p. 254, has also arrived at a similar conclusion from an examination of the fossil mollusca in the neighbourhood of the west coast of Sweden; with this difference, however, that, according to him, "the arctic species present themselves at those spots which are furthest from the coast, while the nearer any locality is to the shore, the rarer are the arctic species, these being gradually replaced by more southern species." Whereas, with us, mere distance from the coast does not afford a test of the age of a fossil, and the older or arctic species are found in the shell-beds at the greatest heights above the sea, and in the clay furthest below the surface, independent of distance from the coast. [This view is remarkably confirmed by the Elie shell-bed described by the Rev. Thomas Brown, F.R.S.E., in his paper read before the Royal Society Edinburgh, March 2, 1863. *Translator.*]

7. Finally, two species have been noticed, viz. *Trochus magus* (in the older beds), and *Tapes decussata* (in the later beds), and to these, perhaps, should be added *Pholas candida*, which no longer inhabit our coasts, but are distributed from the Mediterranean to England. In regard to these species, we can only conjecture that in the Post-pliocene epoch they reached Norway, not from England but from the Mediterranean, between which and the North Sea a communication existed to the east of the Alps.

Nor does this fact stand alone. I have already elsewhere called attention to two other indications of such a connection between these seas at an earlier period, viz.—the well known fact that some of the characteristically

arctic species are found as fossils in Italy and Sicily (*Forhandl. i Vid. Selsk. i Christiana*, 1858, p. 78); and further, the very remarkable fact, that in both these seas perfectly identical species are found living which are absent on the intervening coasts of the Atlantic. Such are, *Nephrops norvegicus* (Cancer), *L. Lotaabyssorum* (Nilss.), (= *Elongata*, Risso. L.), *Sebastes imperialis* (Cuv.), and *Macrourus (Lepidoleprus) cælorhynchus* (Risso). To these I have recently (*l. c.* p. 86) added two shells discovered by me in the sea at Bergen, viz.—*Cerithium vulgatum* (Brug.), and *Monodonta limbata* (Phil.), which are found living in the Mediterranean, but on none of the intermediate coasts between that sea and Norway.

To explain, then, the presence of these species in the Mediterranean and in Norway, with their absence from the intervening coast, we must, as I have already elsewhere remarked (see *Bemærkninger over det adriatiske Havs Fauna, Magaz. f. Naturv.* 7 B. 1853, p. 395), suppose, either that nature, which has so often produced analogous but distinct species, in localities far remote from one another, has in this instance, created perfectly identical species at two so distant points, a fact of which we have absolutely no other instance; or, which is far more probable, that the existence of these species dates from a period—viz., the Post-pliocene, when towards the east a connection existed between the Mediterranean and the North Sea, which at a later period was interrupted by the elevation of the Alps.

In a paper since communicated to the “*Nyt Magazin*,” Dr Sars distinguishes the fossil-bearing beds of the glacial formation into four kinds, different in age and constitution.

1. The older shell-beds, which lie at from 300 to 500 feet above the sea. Loose heaps of entire or broken shells, the bivalves seldom in pairs. The mass of shells sometimes pure, sometimes mixed with fine sand.

These facts prove that such beds are of littoral origin, formed in bays, where their sheltered position preserved them from being swept away and scattered by the waves during the subsequent elevation of the land. That they

have not been carried to their present position is obvious, from the frequency of the littoral *Balanus*, still entire, adhering to the shells and stones, and even to the rock itself.

Further, the shells found in these masses are, without exception, of littoral (for the most part) or laminarian species, the latter, as is the case on existing sea-beaches, having been washed up from the lower zone. Not one deep-water species has ever yet been found in these shell-beds.

The arctic character of these beds is still further confirmed afresh by the specific nature, the numerical proportions,* and the actual size and shape of the shells which form them.

The elevation of the land seems to have taken place gradually and without violence, accompanied by a corresponding diminution in the arctic character of the fauna.

2. The older clay containing shells rarely aggregated in any number, generally sporadically dispersed or thinly spread, usually entire and well preserved, and the bivalves in pairs.

This is plainly a deep-water formation, the shells and Echinoderms found in it belonging to the deep-sea zone. *Dentalium abyssorum*, *Yoldia pygmaea*, *Y. lucida*, *Arca glacialis*, &c., are frequent. *Siphonodentalium vitreum*, *Iso-cardia cor*, &c., are rarer. *Serpula polita* is frequently found attached to the erratic blocks which abound in this clay. The fauna of this clay is markedly arctic. Thus *Arca glacialis* lives now only in Finmark, Spitzbergen, and Melville Island: *Yoldia intermedia*, discovered by Dr Sars in Finmark at 100 fathoms deep, and *Siphonodentalium vitreum*, a rare Finmark species, living from 40 to 100 fathoms deep, and apparently approaching extinction, are much more frequent in the clay-beds.

The evidence of the Echinoderms supports that hitherto obtained from molluscs alone. *Ophiura Sarsii* lives along the whole coast of Norway, at from 20 to 100 fathoms and upwards, but is more frequent and larger in the far north. *Ctenodiscus crispatus*, distinctively arctic, comes south to Christiansund, Lat. 63°10', at from 40 to 200 fathoms. *Tripylus fragilis*, peculiar to Norway, is larger and more frequent in the north, but comes south to Bergen at from 30 to 120 fathoms.

* Thus *Saxicava rugosa*, *Mya truncata*, and *Pecten islandicus*, form from 50 to 80 per cent. of the whole shells.

Note on Lemania variegata of Agardh. By GEORGE LAWSON, LL.D., Ph.D., Professor of Chemistry and Natural History in the Queen's University of Canada.*

In the first part of the second volume of Bishop Agardh's

* Read before the Botanical Society of Edinburgh, 9th April 1863.

"Species Algarum," published in 1828, an alga said to have been found "in *fluviis Americæ borealis*," was described under the name of *Lemania variegata*. Agardh's original description of the plant appears, however, to have been published in the Stockholm Transactions in 1814, to which I have no means of access at the present time. The specimen upon which the species was founded had been given to Agardh by Olaf Swartz, his first master in Algology, who obtained it from the collector, the Rev. Dr Mühlenberg of Lancaster, in Pennsylvania. Not having been met with by subsequent observers, *Lemania variegata* has been looked upon as a long-lost plant.

In a parcel of specimens of cryptogamic plants sent to me in August 1862, by Mr John Macoun of Belleville, Canada West, a most zealous and successful explorer, I at once recognised a *Lemania*, remarkable for its extremely rigid, prominently moniliform, curved filaments, attenuated towards the base and apex, and regularly marked throughout by alternate bands, dark and white,—agreeing, in fact, very well with Agardh's description of *L. variegata*. I doubt not that the Belleville plant is conspecific with that of Agardh, and it is probably the identical form described in the "Species Algarum."

Lemania, Bory.

Generic character.—Fronds bristle-like, rising in clusters from a common adherent base, cartilaginous or corneous, continuously tubular, more or less nodose (brown, dull-green, blackish or parti-coloured), the tube-membrane composed of two distinct closely adherent strata of cells, those of the outer stratum minute, irregularly polygonal, closely united pavement-wise in radiating groups, those of the inner stratum rounded and not conformable, much larger than the others. Spores (so called by authors) in seriated stalked tufts, inside the swollen joints of the tube, and arising either from a central axis (according to Dr W. J. Thomson), or from the inner peripheral layer of cells, or from both.

This genus is named *Lemania* by Bory, in honour of M. Lemain of Paris, "a modest naturalist not less learned in

botany than in the other branches of science," embraces three species of aquatic algæ of very remarkable aspect and structure, which grow attached to stones, rocks, wood, &c., in the bottoms of shallow, rapid, fresh-water streams. Unlike most fresh water algæ, they have dense compact tissue, giving them firm consistence; they are rich in nitrogen, and when burned yield ammoniacal vapours. The plant usually consists of a little tuft of stiff erect or curved bristle-like fronds, which adhere by a common discoid root to submerged objects. The minute structure of these plants has been illustrated very fully by authors at different times, from Vaillant (1727) downwards, with singularly conflicting results. The most recent, and perhaps most valuable contribution that has been made to the history of *Lemania*, is the remarkably lucid description of Dr W. J. Thomson, in the Transactions of the Botanical Society of Edinburgh, vol. vi. page 243, to which I would refer observers as an excellent basis for further inquiry, although I have been unable (probably from my specimens being too matured) to confirm some of Dr Thomson's results. Mr Thwaites of Ceylon has carefully studied the early development of the frond, and states that the spores at first vegetate into slender confervoid filaments, with long joints containing spirally-arranged endochroms. The filaments constitute a sort of prothallus or pro-embryo, the initial state of the plant. After a time thick branchlets, the germs of the perfect and permanent frond, spring from the cells of the confervoid filament; they are at first wholly dependent upon the cell from which they rise, but soon acquire rootlets at their base, and, rapidly elongating, grow into the densely cellular, opaque, cartilaginous bristle-like tubes, so characteristic of the mature plant in this genus.

L. variegata.—Fronds tufted, of simple bristle-like tubes, rigid, corneous, attenuated towards the base and apex, moniliform, with black or dark-brown swollen elliptical nodes, and pellucid, colourless, constricted internodes of equal length.

“*Hippuris fluviatilis petræa nuda Virginiensis*, Pluk. Phyt. tab. 193, fig. 7.” (Agardh.)

“*Lemania variegata*, Agardh, Act. Holm., 1814, tab. 2, fig. 3.” (Agardh.)

“*Lemania variegata*” (Agardh), Species Algarum, vol. ii. page 7.

In the bed of the Moira above Belleville, Canada West, on rocks, rare (August 1862), John Macoun, sp. “In fluviis Americæ borealis. Specimina a Muhlenbergio missa communicavit Swartz” (Agardh).

The following eight forms of this extremely interesting genus have been described by Agardh:—

1. *L. fluviatilis* = (*Conferva fluviatilis* lubrica setosa, Equiseti facie, Horse-tail River *Conferva*, *Dillenius*, Hist. Musc., tab. vii. fig. 47. *Conferva fluviatilis*, *Linn.*, *Mohr*, *Roth.*, &c. *Polysperma fluviatilis*, *Vauch.* *Chantransia fluviatilis*, *DC.* *Lemania corallina*, *Bory.* *Nodularia fluviatilis*, *Lyngb.*) This is the more common British species which I gathered in quantity in a stream on the Ochil Hills, near Stirling, in 1857. It has also been recorded as growing near Bangor (*Dillenius*), in Winterbourne Stream, Lewes (*W. Borrer*); at Hamsell, and at the waterfall at Harrison’s rocks (*E. Jenner*); Aberdeen, abundant (*Professor Dickie, M.D.*); Ireland, frequent (*D. Moore*); Scandinavia, Germany, France, Corsica.
2. *β. tuberculosa* = (*Nodularia fluviatilis* ramosa, *Lyngb.*) Denmark.
3. *γ. media* = (*Conferva fluviatilis*, *Dillw.*, E.B., t. 1763). England.
4. *δ. fucina* = (*Lemania fucina*, *Bory.* *Chantransia dichotoma*, *DC.* France, chiefly in Bretagne.
5. *ε. subtilis* = (*Lemania subtilis*, *Agardh* (in Act. Holm. 1814, t. 2, f. 4, Kützing.) Sweden, &c.
6. *L. torulosa* = (*Conferva fluviatilis* nodosa *Fucum æmulans*, Sea Horse-tail-like *Conferva*, *Dill.* Hist. Musc. tab. vii. fig 48. *Conferva torulosa*, *Roth.*, *Mohr.*, *Dillw.*, &c. *Lemania incurvata*, *Bory.*) Recorded as occurring in mountain streams near Ludlow, Salop (*Dillenius*), Anglesea (*Rev. H. Davies*); also in France, Germany, Kentucky, United States (*Dr Short* in Harvey, Nereis).
7. *β. usneoides* = (*Conferva usneoides*, *Wallr.*) Saxony.
8. *L. variegata* = (*Hippuris fluviatilis* petræa nuda *Virginiensis*, *Pluk.*) Belleville, Canada West (*J. Macoun.*) United States, Pennsylvania? (*Mühlenberg*).

may be found, on investigation, to be well-marked species. The various forms deserve a careful examination, and I would beg to direct the attention of British botanists to the subject.

Descriptions of New Genera and Species of Diatoms from the South Pacific. By R. K. GREVILLE, LL.D., F.R.S.E., &c.* (Plate I).

The diatoms described in the present communication were all obtained from dredgings made on various coasts in the South Pacific, and kindly placed in my hands by my obliging correspondent Dr Roberts of Sydney. Many other novelties, of equal interest, contained in these dredgings, will (D.V.) form the subject of future papers.

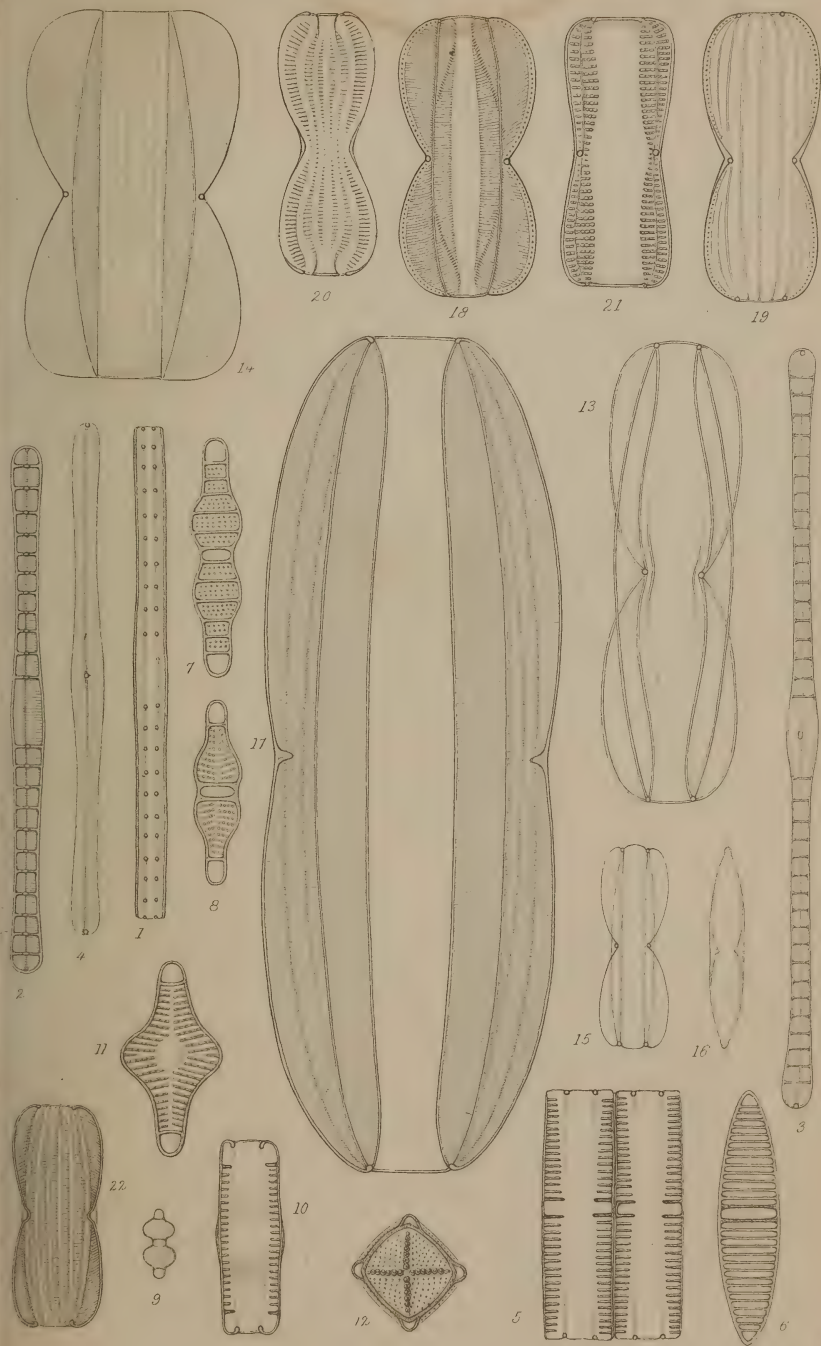
STICTODESMIS, nov. gen., Grev.

Frustules elongated (sessile?), in front view linear, rectangular, with two conspicuous rows of puncta disposed in pairs; side view linear, with terminal and central nodules, median line, and numerous transverse pervious septa.

It is difficult to indicate the systematic position of this curious diatom. The transverse septa, as shown in the lateral view, and very elongated form, are suggestive of some affinity with *Climacosphenia*: but from that genus and the other, *Licmophoræ*, it differs in the linearity of the frustules, and in the presence of nodules and a median line, as well as in the different nature of the septa themselves. With the *Fragillariæ* it might be compared in its pervious septa, conjoined with the similarity of both ends of the frustule; but *Stictodesmis* is not compressed in the lateral view; and here also the median line and nodule, and position of the septa, indicate a different structure and different relations. The genus, in fact, cannot be referred to any of the families as at present constituted.

Stictodesmis australis, n. sp., Grev.—(Pl. I. figs. 1-4). *Hab.* Harvey Bay, Queensland, and at Port of France, New Caledonia; in dredgings communicated by Dr Roberts of Sydney.

* Read before the Botanical Society of Edinburgh, 14th May 1863.





Frustules much elongated, from $\cdot 0055''$ to $\cdot 0100''$, the breadth scarcely more than $\cdot 0004''$. Front view linear, rectangular, with two longitudinal rows of brilliant puncta in pairs, at some distance from the margin, the space between the rows and the margin very finely striated, while that between the rows forms a smooth, blank line. Lateral view linear, slightly dilated at the middle, and generally, also, more or less at the rounded ends, with a median line, and terminal and central nodules, the line being situated slightly nearer to one side than the other; transverse septa pervious, strong, subequidistant, numerous, upwards of twenty in the shorter frustules, nearly double that number in the longest; very fine transverse striæ also cover the whole space. Besides the above front and lateral views, the valve must be noticed separately, being distinguished by the median line and nodules and the fine striæ only, and is so thin and transparent that it is easily overlooked. The septa belong to an internal arrangement, being perceived in the front view to be placed at about a third of the entire breadth of the frustule from each side, or, in other words, from the valve. The puncta, which shine like brilliant points of light, are of course the sutural terminations of the septa viewed vertically. The shorter figures are from the Harvey Bay dredging, the long one from New California.

PLAGIOGRAMMA.

Plagiogramma costatum, n. sp., Grev.—Front view with nearly straight sides and sharp angles; valves lanceolate, with two central vittæ; striæ costate, pervious, 10 in $\cdot 001''$. Length about $\cdot 0030''$ (figs. 5, 6).

Hab. New Caledonia; in a dredging communicated by Dr Roberts.

This species is well distinguished by its clear costation and central pair of vittæ. It is by no means unfrequent in the dredging.

Plagiogramma spectabile, n. sp., Grev.—Valves constricted in the middle, then dilated and slightly lyriform; vittæ numerous (about twelve), with intermediate transverse lines of minute puncta. Length about $\cdot 0030''$. (fig. 7).

Hab. New Caledonia ; in a dredging communicated by Dr Roberts. Very rare.

Of this diatom I have only seen two examples ; but the characters are so remarkable, that there can be no doubt of its novelty as a species. The central constriction, it now appears, is not uncommon in this genus.

Plagiogramma constrictum, n. sp., Grev.—Valve constricted in the middle, then suddenly dilated and lyriform, with terminal and central vittæ ; striæ moniliform, interrupted, 11 in $\cdot 001''$. Length about $\cdot 0025''$ (fig. 8).

Hab. New Caledonia ; in a dredging communicated by Dr Roberts.

Allied to *P. lyratum*, but differing in the smaller size of the frustule, in the relatively much broader valve, more abrupt constriction, more approximated central vittæ, and much fewer striæ.

Plagiogramma Atomus, n. sp., Grev.—Very minute ; valve with terminal and central vittæ ; the intermediate spaces spherically dilated ; striæ few, pervious. Length, $\cdot 0005''$ (fig. 9).

Hab. Woodlark Island ; in a dredging communicated by Dr Roberts.

The smallest of the genus hitherto discovered, distinguished by the very deep constriction and spherical form of the dilated portions, each of which contains about half a dozen striæ.

OMPHALOPSIS, nov. gen., Grev.

Frustules united into a filament ; lateral view cruciform, with central nodule, terminal vittæ, and interrupted transverse striæ.

This genus is allied on the one hand to *Plagiogramma*, on the other to *Glyphodesmis*. From the former it differs in the absence of central vittæ ; from the latter, in the presence of terminal vittæ, as well as in difference of structure, the remarkable clathrate cellulation being wholly wanting. In the cruciform lateral view it resembles *Odontidium*, (?) *Harrisonii* of Smith, and *O. speciosum* of Brightwell (both placed by Ralfs in his genus *Dimere-*

gramma), but is far removed in structure by its vittæ and central nodule.

Omphalopsis australis, n. sp., Grev.—(Figs. 10, 11).

Hab. Woodlark Island ; in a dredging communicated by Dr Roberts. Not unfrequent.

Frustules varying considerably in size, but generally about '0022" in length, rectangular, the angles slightly rounded, and the striæ forming a very narrow marginal border ; valve cruciform, about '0012" in breadth in the middle ; nodule large, prominent, circular ; striæ 11 in '001", strong, submoniliform, somewhat oblique, radiating in the centre, where a short one usually occurs at the outer margin, interrupted, leaving a narrow blank median space which terminates at the vittæ which cut off the rounded ends. At first sight, the large boss-like nodule and robust striæ convey an impression that the valve may belong to a species of *Glyphodesmis*, but, as already remarked, the terminal vittæ and different structure essentially separate it.

AMPHITETRAS.

Amphitetras parvula, n. sp., Grev.—Lateral view with the sides slightly convex, the angles rounded, containing a large pseudo-opening ; centre marked by two cruciform lines of cellules which intersect each other in the middle and give off radiating lines of minute puncta. Breadth between the opposite angles '0015" (fig. 12).

Hab.—New Caledonia ; in a dredging communicated by Dr Roberts. Very rare.

Frustule very small, quadrangular, the sides very slightly convex, the rounded angles being formed by the pseudo-openings which are very conspicuous, the true margin, continued on the inner side of the openings, strong and dark, outside of which the edge of the connecting zone appears constituting a secondary margin, which passes to the apices of the pseudo-openings. The internal space is equally divided by two lines crossing in the middle, composed of two contiguous rows of cellules, which are mostly visible in consequence of the shadow they produce, while from each side of these rows pass inclined lines of very minute puncta.

This exceedingly distinct little species is about the same size as *A. crucifera* of Kitton, and resembles it to a certain extent in the internal cruciform arrangement. But in the last-named species there are no pseudo-openings, the produced rounded angles being simply an extension of the internal surface. There is a difference also in the cruciform appearance, which in *A. crucifera* is produced by the position and larger size of puncta, similar to those which fill up the rest of the space, and which do not cause the line of shadow above mentioned. Although the form is exceedingly rare, I have seen and examined several specimens.

AMPHIPRORA.

Amphiprora eximia, n. sp., Grev.—Front view elongated, oblong, rounded at the ends, deeply constricted at the middle, one supplementary wing convex and widely overlapping the constriction, a second passing over the nodule where it is somewhat constricted, and within the nodule a short elevated longitudinal ridge. Length about '0060" (fig. 13).

Hab.—Curteis Straits, Queensland; in a dredging communicated by Dr Roberts.

A singularly graceful species. Nothing can be more beautiful than the harmony of the various intersecting lines. As far as I can make them out, there are two supplementary wings, the largest very broad, arising at the terminal angles of the valve, and with a gentle curve overlapping the constriction so much as to bring the convexity of the supplementary wing almost into a line with the widest part of the frustule. The second supplementary wings (if they be truly wings) also arise from the same point, soon curve outwards, and then, becoming constricted at the nodule, have a somewhat lyrate appearance. Lastly, there is just within the nodule a little ridge (or abortive wing?) which is parallel to, and follows the curve of the second supplementary wing, and disappears at less than half way between the nodule and the ends. I have not been able to resolve the striæ.

Amphiprora lata, n. sp., Grev.—Front view very broad (breadth more than half the length), truncate at the ends,

with the corners very widely rounded, rather deeply and acutely constricted; supplementary wing narrow, convex, not reaching the constriction; central portion with faint lines or folds. Length about $\cdot 0040''$, breadth $\cdot 0028''$ (fig. 14).

Hab.—Curteis Straits, Queensland; in a dredging communicated by Dr Roberts.

It was not until I had seen a number of examples of this diatom that I began to regard it with any confidence. There can be no doubt that some of the *Amphiproræ* are liable to considerable variation; and the very broad, squat appearance of the frustules now before me made me suspect that they might turn out to be a variety of some large species. All the specimens, however, present precisely the same characters, and I am consequently prepared to offer it as a genuine species. From *A. maxima* of Gregory it differs not only in form, and in the much narrower supplementary wings, but very strikingly in the more truncated ends. The striæ are readily brought out.

Amphiprora delicatula, n. sp., Grev.—Minute, hyaline; front view oblong, with rotundato-truncate ends and deep lateral constriction; supplementary wing very narrow, slightly overlapping the nodule; lateral view lanceolate, the apices slightly produced and minutely truncate. Length about $\cdot 0025''$ (figs. 15, 16).

Hab.—Woodlark Island; in a dredging communicated by Dr Roberts. Not uncommon.

A most delicate and graceful species, easily overlooked on account of its small size and hyaline character. I have been unable to make out the striæ.

Amphiprora? superba, n. sp., Grev.—Very large; front view elongated oblong, slightly constricted, widest part about half way between the ends and middle, each extremity gradually converging to the angle of the connecting zone, which is truncate; supplementary wings rather broad, linear, directed inwards with two longitudinal lines between them and the margin. Length $\cdot 0108''$ (fig. 17).

Hab.—New Caledonia; in a dredging communicated by Dr Roberts. Extremely rare.

This fine diatom may perhaps be regarded as belonging

doubtfully to the present genus. In some respects it is not unlike a gigantic *Amphora*; but the position of the nodules, and the apparent existence of what I have called supplementary wings, are opposed to its being referred to that genus. There are, however, some very aberrant forms discovered by my friend the late Professor Gregory, and several more recently observed by myself, which render the generic discrimination of *Amphiprora*, in the absence of the valvular view, somewhat difficult. The panduriform outline in some instances disappears altogether, the constriction is occasionally scarcely perceptible, and the wing inconspicuous. The striæ in the present diatom are transverse, 27 in $\cdot 001''$, and sufficiently evident.

Amphiprora nitida, n. sp., Grev.—Small; front view panduriform, broadly rotundato-truncate at the ends, rather deeply and sharply constricted, margin with a row of minute puncta; supplementary wings linear, forming a nearly straight line, which passes within the constriction; another ridge-like line converging towards the middle at each end. Striæ conspicuous. Length from $\cdot 0020''$ to $\cdot 0035''$ (fig. 18).

Hab.—Curteis Straits, Queensland; in a dredging communicated by Dr Roberts.

A beautiful and apparently very distinct small species, characterised at once by the lines of the supplementary wings and the superficial ridges. The supplementary wing is linear, passing on each side from end to end in a very slight curve just within the nodules. At the ends it turns almost at a right angle to join the middle portion, and thus a sort of parallelogram is produced, which, when focussed for itself, is very striking. Another very characteristic line seems to be caused by an elevated ridge, commencing on each side at the angle of the middle portion or connecting zone, curves outwards until it reaches the margin of the supplementary wing, which it then follows for about a third of its length, when it leaves it and curves in a similar way towards the middle portion at the opposite end. The surface is thus much undulated, as is shown by the different directions taken by the striæ.

Amphiprora lineata, n. sp., Grev.—Front view oblong,

broadly rounded at the ends, and moderately constricted at the middle, with a marginal row of very minute puncta; surface marked with straight longitudinal lines or folds (about seven); striation obscure. Length about $\cdot0038''$ (fig. 19).

Hab.—Woodlark Island; in a dredging communicated by Dr Roberts. Rare.

In this species we find no distinct trace of supplementary wings, but in their place a few equidistant longitudinal lines or folds, which cannot be prominent as they cast very little shadow.

Amphiprora? Clepsydra, n. sp., Grev.—Front view oblong, rotundato-truncate at the ends, much, but not sharply constricted at the middle; striæ coarse, forming a narrow intramarginal band, and two inner ones still narrower, the two outermost following the curve of the margin, and converging at the ends. Length $\cdot0034''$ (fig. 20).

Hab.—Curteis Straits, Queensland; in a dredging communicated by Dr Roberts. Very rare.

Here, again, we have a diatom very different indeed from what has been regarded as typical of *Amphiprora*. It will be perceived that the system of striation is quite unlike, the outer band being distinctly radiate. The inner bands may be regarded as supplementary wings. The constriction is not sharp, as in most of the preceding species, but rather deeply concave.

Amphiprora? paradoxa, n. sp., Grev.—Front view quadrangular, with truncated ends, and rounded corners very slightly and gradually constricted at the middle; supplementary wings broader than the primary ones, and also constricted opposite the nodule; striæ robust, moniliform, 10 in $\cdot001''$. Length $\cdot0035''$ (fig. 21).

Hab.—Curteis Straits, Queensland; in a dredging communicated by Dr Roberts.

In the robust and distinctly moniliform striæ of this diatom we have another deviation from the ordinary structure of *Amphiprora*, so strongly marked as to render it evident, that although it may be convenient in the meantime to refer some of these forms to that genus, a re-arrangement will soon become necessary. The possession of the

valve might serve to show more exactly their relations ; but the probability of obtaining a side view of the frustule is so remote, that I prefer giving figures of these interesting objects at once, to laying them aside for an indefinite period. It only requires to be understood that their position in the genus is provisional. There is no reason why the same latitude should not be allowed in the publication of Diatoms as in that of other plants ; and especially of other algæ. For example, while engaged in the description of these *Amphiproræ*, the 49th Part of my friend Professor Harvey's admirable "Phycologia Australica" has appeared, in which, under *Cryptonemia decipiens*, he remarks, "In now referring it to *Cryptonemia*, I must be understood to do so provisionally, until the discovery of its fruit enable us to assign it its proper place in the system." This is a most reasonable privilege. It may be observed, with regard to the frustules now before me, that there is all the appearance of a distinct wing, which becomes narrower as it approaches the constriction, as in the known *Amphiproræ*.

Amphiprora? undulata, n. sp., Grev.—Small ; front view quadrangular, with rounded angles, and nearly straight sides, and a slight, somewhat notch-like constriction ; surface rather coarsely striated, and undulated with longitudinal ridges, the two principal ones curving outwards, and passing just within the constriction. Length about '0030" (fig. 22).

Hab.—Curteis Straits ; in a dredging communicated by Dr Roberts.

This species is as rectangular in its outline as *A. pusilla* of Gregory. The two outer prominent ridges or folds evidently occupy the place of supplementary wings, while the inner ones are merely undulations, sufficiently decided, however, to throw the striæ which cross them out of focus. I have examined a number of examples, but have not succeeded in finding a valve. The latter would no doubt assist in determining the genus in the case of aberrant forms ; but I apprehend that in most instances the specific character will be best obtained from the front view.

DESCRIPTION OF PLATE I.

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|---------|---------------------------------|----------------------|-------------|
| Fig. 1. | <i>Stictodesmis australis</i> , | . | front view. |
| 2. & 3. | " | " | side view. |
| 4. | " | " | valve. |
| 5. | <i>Plagiogramma costatum</i> , | | front view. |
| 6. | " | " | side view. |
| 7. | " | <i>spectabile</i> , | side view. |
| 8. | " | <i>constrictum</i> , | side view. |
| 9. | " | <i>Atomus</i> , | side view. |
| 10. | <i>Omphalopsis australis</i> , | | front view. |
| 11. | " | " | side view. |
| 12. | <i>Amphiteras parvula</i> , | . | side view. |
| 13. | <i>Amphiprora eximia</i> , | . | front view. |
| 14. | " | <i>lata</i> , | front view. |
| 15. | " | <i>delicatula</i> , | front view. |
| 16. | " | " | side view. |
| 17. | " | ? <i>superba</i> , | front view. |
| 18. | " | <i>nitida</i> , | front view. |
| 19. | " | <i>lineata</i> , | front view. |
| 20. | " | ? <i>Clepsydra</i> , | front view. |
| 21. | " | ? <i>paradoxa</i> , | front view. |
| 22. | " | ? <i>undulata</i> , | front view. |

All the figures are $\times 400$ diameters.

On the question, Is Oxide of Arsenic, long used in a very small quantity, injurious to Man? By JOHN DAVY, M.D., F.R.SS. Lond. & Edin.*

The facts which led me to propose the above question were the following:—In Cumberland, within a stone's cast of the Coast's Railway, between Whitehaven and Broughton, is the little church of the parish of Whitbeck, and also the farm-house of Whitbeck-head,—names these derived from the small mountain stream which descends from Black Comb, and so rapidly as to be an almost white line of foam. The hamlet, situated at the foot of the hill, consists of the farm-house just mentioned, and of five cottages, each occupied by a family dependent for water on the rivulet, "the Beck," their inmates using no other. The same water is drunk by the cattle of the farm, and by the poultry, fowls, geese, and ducks; and, as regards all, with one excep-

* Read at the Meeting of the British Association in 1862.

tion, its wholesomeness has never been called in question. The one exception has been in the instance of ducks, which, according to report, never could be reared there.

No attempt that I am aware of was made to account for this exceptional effect until about two or three years ago, when the water was examined by Mr Arthur H. Church, and was found by him, it was said, to contain arsenic,—an alkaline arseniate, and in a determinate quantity. The first notice of this gentleman's results that I saw was in an extract from the *Whitehaven Herald*, in which it was stated that "the arsenical water is habitually used for every purpose by the inhabitants of the little village of Whitbeck, and with beneficial results so apparent that one might be justified in paradoxically characterising it as a very wholesome poison, the deadly elements in solution being productive of the most sanatory effects." It is immediately added, "It is true ducks will not live if confined to Whitbeck; and whilst trout abound in the neighbouring rivulets, no fins are ever found in this arseniated stream." Further, it is said, that "when the railway was being carried past Whitbeck, the first use of the water produced the usual marked effects on the throats both of the men and horses employed on the works. The soreness of mouth from which they first suffered soon however disappeared, and in the horses gave rise to that sleekness of coat assigned as one of the principal effects produced by the administration of minute but repeated doses of arsenic."

This notice, which I have since found is nearly a travesty of Mr Church's, published in the "*Chemical News*" for August 25, 1860, exciting my curiosity, I paid a visit to the stream on the 27th August of last year, ascending to one of its sources, probably 700 feet above the level of the sea, where it issues from the gallery of a forsaken mine, and thence followed it in its descent to the village. In this its course, of about a mile, it was joined by other small streams, and by one from a lateral valley equal in size to that which it meets. The temperature of the water close to the mine-gallery was 48° at the time that the open air was 60° ; lower down, just before entering the village, it was 58° . I then collected a portion of water for examination, and had other

portions sent me; one in October, when the stream was of moderate size; another, in January, when it was lower than usual, after a frost of many days continuance; and a fourth I collected myself when I last visited the stream, viz. on the 3d of August of this year, when it was of its average height, and when the water of the mine-branch was $51^{\circ}5$, and of the lateral branch $50^{\circ}5$.

Before mentioning the results of my trial of these specimens of water, I shall give a brief summary of the information which I obtained from the inhabitants of the village.

The statement about the ducks was verified; and also that no fish had ever been seen in the stream. Nothing was known of its having had any of the effects attributed to it when first used by the labourers and horses employed on the railway; indeed, there was a positive contradiction given by the mother of a young family of children who had come to reside at the village after the line was opened. Nor could I learn that any of the inhabitants thought that any special good effect on their health was due to their habitual use of the water. My chief informant was Mrs K., a widow of about 60, of Whitbeck-head, residing in the farm-house, the mother of twelve children, all of whom were born and brought up in the same place, and had good health. She was not a native of the spot, but had lived there uninterruptedly about forty years—that is, from the time of her marriage; and when I saw her she was active for her age, was in good health, and said she always had been healthy. According to her, so fruitless had been all her attempts to rear ducks that she had given them up as hopeless. Their death, she stated, was preceded by a wasting; and that, on examination after death, their stomachs were found “unusually crammed” or distended; all other poultry doing well.

I shall now speak of the water of the Beck. It had the general character of the mountain-streams of the Lake District, was perfectly clear, and colourless and tasteless. Of the several specimens obtained, I found the specific gravity the same, and the same as that of distilled or rain-water. When evaporated to dryness the residue was very small, a pint yielding about $\cdot 25$ of a grain—and, from the different

specimens tried, not varying more than one-tenth of a grain. In each instance this residue was found to consist chiefly of common salt; it tasted of this salt, and in solution was copiously precipitated by nitrate of silver. Mixed with the common salt was a little magnesia and lime, both probably in combination with sulphuric acid, as sulphate of lime and of magnesia, the presence of the acid being denoted by nitrate of barytes; a trace, too, of oxide of arsenic was detected in each, and it may be inferred, in combination with potash, a trace of which also was obtained. The arsenic was detected not only by the test of the ammoniaco-nitrate of silver, but also by reduction to its metallic state by sublimation, after mixture with ferro-cyanide of potassium. Of the several specimens of water tried, that procured in October, when the stream was about its ordinary size, afforded a somewhat stronger trace of the metal than either the earlier or later, the one in August 1861, taken when the stream was swollen after rain; the other in January 1862, during a frost of several days' duration, when probably the water was frozen at its sources,—the stream then lower than common. In noticing, however, the later, I should except the last, that taken in August last, when the stream was of about its average volume, and the indications of arsenic nearly the same as those of October. In the instance that the trace was strongest, judging from comparative experiments with oxide of arsenic,—experiments of reduction by sublimation,—the quantity of oxide contained in the pint was only about $\cdot 008$ grain, or $\cdot 064$ grain to the gallon.

Before concluding this part of my subject I may mention that in the second visit which I made to the stream, then in company with Dr Robinson of Newcastle, we paid particular attention to the herbage and plants growing close to or in the water, and were unable to observe anything in their appearance indicative of a noxious influence on them, with the exception—if it be an exception—of a single tree, a maple (*Acer campestre*), growing where its roots were washed by the descending stream; of its branches many were dead, and such was its general aspect that it might well represent a poisoned tree; yet, that it was poisoned, is

very doubtful, judging from the circumstance that its fructifying power was not apparently impaired, seed-vessels being abundant on it. At my last visit I saw sheep browsing on the grass that grew at the edge of the stream : and then I was struck not only by the variety of the kinds of plants, but also by the freshness and healthy appearance of those so near as to be in the way of being sprinkled with the spray of the little torrent. At the same time that I had the advantage of the company of Dr Robinson, we sought for larvæ in the sediments of a little pond, which had been formed as a reservoir for the purpose of working a mill belonging to the farm, but without success. The only living things we saw, and these were not in the water, were some small spiders, which were actively skimming its surface. In a portion of the sediment which I brought away, subjected to the microscope, I found a few remains of Infusoria. It may be worth mentioning, that when the bottom of the pond was stirred much air was disengaged. Dr Robinson was so good as to have a portion of it collected and sent to me. I found it to be almost entirely azote ; it was not diminished by agitation with milk of lime, and hardly perceptibly by phosphorus ; nor was it inflammable. As the deposit had an ochrey hue, perhaps the separation of the oxygen, which most waters contain, was owing to the action of a protoxide of iron in process of conversion into the peroxide.

To revert to the arsenical impregnation. If it be asked whence it was derived, we have not far to seek : the obvious inference is, that the very minute quantity of arsenic in the water is owing to the water flowing over mineral substances of which arsenic is a constituent part, such as arsenical pyrites, which I am informed was abundant in the mine,—(a vein that was worked for cobalt), and is of common occurrence in the side of Black Comb. Dr Robinson, who had collected some specimens of it, favoured me with a portion of them ; and from water, in which they had been immersed a few hours, traces were detected of oxide of arsenic, and also of iron and copper ; and in confirmation, I may state, that when, at my last visit, I tested on the spot the two streams before adverted to, which by their junction form

the Beck, I found the indications of arsenic in the one, of about the same degree of distinctness as in the other.

As regards the question proposed,—Is arsenic in very small quantity, long continued in use, injurious to man?—do not the results described and the experience related justify an answer in the negative? To me they seem to warrant this conclusion, and also the conclusion equally, that no appreciable good effect is produced in the instance of man, or in that of the other animals mentioned, by its long-continued use; and in confirmation of this I may state, that one of the inhabitants of the village, a blacksmith, who on taking up his abode there some years ago, was subject to attacks of asthma, assured me that his complaint had from year to year been becoming worse rather than better.

In a recent number of the *Journal de Médecine et Chirurgie Pratiques*,* there is a notice of a thermal spring (its temperature that of 106° Fahr.) in the regency of Tunis, called Bon-Chater, the water of which, from the analysis made of it by M. Guyon, contains a large proportion of arsenic in the state of arseniate of potash and of soda, larger indeed than any other yet known, being as much as four grains to the gallon; and yet we are assured, that it was used not only by the natives with impunity, but also by M. Guyon and his party.

If, then, not noxious, used as above described, is there not another inference to be drawn,—viz., that arsenic, especially in combination with either of the alkalies, is not one of those substances which accumulate in the system; is, on the contrary, as commonly admitted, one of those which are got rid of by excretion,—its elimination varying, probably, in different persons and in different animals as to rate, and varying, it may be, proportionally in the measure of its tolerance? Analogy seems to favour this view. The tolerance of certain substances taken in slowly increasing doses is very remarkable. I was assured by the medical man under whose care “The Opium-Eater,” the late Mr De Quincey placed himself, that at the height of his indulgence he took half a pint of laudanum daily. The same practitioner assured me that another patient of his, a lady whom I knew,

* Tom. xxxii. 369.

took daily two drams of solid opium, but not without injury to her fine mental faculties. I may mention another instance, and one more extraordinary, which came to my knowledge at Constantinople, of a Turk who took daily, and for fifteen years, two drams of solid opium, with half that quantity of corrosive sublimate. My informant knew the man well,—he was a porter at the arsenal (of which my friend was an official), and though in shattered health, was capable of his easy duties. I obtained a specimen of what was used as corrosive sublimate, and, testing it, found it to be this compound, of ordinary purity. The main motive for its use, he said was, that it improved—increased, the effects of the opium. This instance, according to the apothecaries in Pera, is not a solitary one of its kind; their experience having taught them that the opium-eater has recourse to it when the narcotic has ceased to have its original effect.

The tolerance of certain substances, in connection with their elimination, has not, I am disposed to think, had all the attention which it deserves. Why is it that individuals living under the same circumstances, using the same kind of diet and the same drinks, are some of them subject to gout, whilst others are free from it? Is it not because the latter possess in their organisation a greater power of eliminating the *causa mali*—lithic acid? Why is it that nitrate of silver long used, in some persons (the very few) becomes—that is the metal—lodged in the cutis vera, occasioning there its peculiar discolouring effect, whilst in the majority, after long use, no effect of the kind is witnessed? Is not the rationale of the difference the same?

We have had it confirmed that the water of Whitbeck is, in the solitary instance of the duck, injurious; ultimately it would appear to be fatal. This may be owing, it may be conjectured, to the duck seeking its food so much more in water, and to a delicacy, an idiosyncrasy rendering it peculiarly susceptible of the effect of arsenic; a peculiarity itself which may be connected with a feeble eliminating power, especially of the kidneys, its urine, like that of birds in general, approaching to a solid.

A somewhat similar instance of great susceptibility of the effects of arsenic occurs, I believe, in the charr, one of the

most delicate, the most sensitive of noxious influences of all the Salmonidæ. It is an established fact, that in the two or three instances in the Lake District, that mines have been opened in the vicinity of lakes, their drainage entering the lakes, the charr has either entirely disappeared, as at Ulswater, or has become very scarce, as at Coniston-water, the trout, a hardier fish, remaining. I have examined the water flowing from the Coniston copper mines into the lake of the same name, and have detected in it distinct traces of arsenic ; and I have obtained a like result from the examination of the water flowing into Ulswater, which receives the drainage of an adjoining lead mine.

Recently, much alarm has been felt from apprehension of arsenic-poisoning, owing to the great use made of some of its compounds, especially of Scheele's green—the cuprio-arseniate—in colouring paper and articles of dress. Probably the apprehension is an exaggerated one; but yet there seems some foundation for it, especially in the case of women employed in making artificial flowers, and in that of ladies wearing those flowers in ball-dresses, coloured by the arsenic compound. If there were only a risk of injury, and that there certainly is in these instances, of a poisonous effect, ought it not to act powerfully as a prohibition to the further use of articles so coloured? Even the most insensate votaries of fashion who may defend crinoline, asserting that, with caution, they are safe from combustion, will hardly venture to defend the use of a poisoned dress, from the slow effects of which, undermining health and spoiling beauty, no ordinary precautions can be effectual.

When we reflect on the abundance of arsenical pyrites in most of our mining districts, and the numerous springs issuing from mineral strata, the water of which is used by the inhabitants, it may be asked how is it that arsenicated water is not of common occurrence, and its poisonous qualities well established? The answer to this, I apprehend, is not difficult, resting on two facts—one, the slight solubility of the oxide of the metal in cold water; the other, its harmlessness in very minute quantities. As to the first, so slowly is it soluble at ordinary temperatures, that we learn, on good authority, it may be digested for many days with

100,000 times its weight of water, and yet not be entirely dissolved. This, its slowness of solution, is probably owing to its comparatively high specific gravity, in consequence of which the oxide falls to the bottom, and to the strong coherence of its particles, resisting its disintegration. Whatever the explanation may be, the property is a fortunate one for animal life; for were it readily soluble, were it more than very slightly soluble, how direful might have been the results! May we not view it as one of the many happy adaptations which are so common in the economy of Nature, and an instance of the limitation of the noxious, or its neutralization, or even more, of its transition into positive good? this last, on the supposition that arsenic used in a very minute quantity may really be beneficial.

Illustrations of the Significance of certain Ancient British Skull Forms. By DANIEL WILSON, LL.D., Professor of History and English Literature, University College, Toronto.

During a recent visit to Washington, I availed myself of the facilities afforded me by Professor Henry, the learned secretary of the Smithsonian Institution, to examine with minute care the ethnological collections preserved there, including those formed by the United States Exploring Expedition; and especially a highly interesting collection of human crania. The latter includes those of Esquimaux and Tchuktchi, a number of compressed and greatly distorted Chinook and other Flathead skulls, as well as examples of those of other Indian tribes, both of North and South America; and of Fiji, Kanaka, and other Pacific islanders. On my return I spent a short time in Philadelphia, chiefly for the purpose of renewed study of the valuable materials of the Mortonian collection; and while there enjoyed the opportunity of examining, in company with Dr Aitken Meigs, a series of one hundred and twenty-five Esquimaux crania obtained by Dr Hayes in his Arctic journey of 1854.

The materials for craniological investigation which such collections supply can scarcely be surpassed in some of their

departments, and invite to very diverse researches by the illustrations they are calculated to afford. It chanced, however, that my attention had been recently recalled to an old subject of speculation, relative to the possible modification of the forms of ancient British crania by some of the very causes which so materially alter those of many American tribes; and this accordingly influenced me in part, in the notes I made of the collections both at Washington and Philadelphia, and will now give direction to some remarks bearing on the same inquiry.

Among the most prized crania in the collection of the Academy of Natural Sciences at Philadelphia is the celebrated Scioto Mound skull. But though on a former visit I made the ancient mound crania an object of special study, this most remarkable example of the series was not then included among them; and I now examined the original for the first time. The result of this examination was to satisfy me that the remarkable form and proportions of that skull are much more due to artificial influences than I had been led to suppose from the views published in the "*Smithsonian Contributions to Knowledge*."* The vertical view, especially, is very inaccurate. In the original it presents the peculiar characteristics of what I have before designated as the truncated form; passing abruptly from a broad flattened occiput to its extreme parietal breadth, and then tapering with slight lateral swell, until it reaches its least breadth immediately behind the external angular process of the frontal bone. The occiput has been subjected to the flattening process to a much greater extent than is apparent from the drawings; but at the same time it is accompanied by no corresponding affection of the frontal bone, such as inevitably results from the procedure of the Chinooks and other Flathead tribes; among whom the desired cranial deformation is effected by bandages crossing the forehead, and consequently modifying the frontal as much as the parietal and occipital bones. On this account, great as is the amount of flattening in this remarkable skull, it is probably due solely to the undesigned pressure of the cradle-board acting

* *Ancient Monuments of the Mississippi Valley*, pl. xlvii. and xlviii.

on a head of remarkably brachycephalic proportions and great natural posterior breadth. The forehead is fully arched, the glabella prominent, and the whole character of the frontal bone is essentially different from the Indian type. The sutures are very much ossified, and even to some extent obliterated. So early as 1857, when discussing Dr Morton's theory of one uniform cranial type pervading the whole ancient and modern tribes of North and South America, with the single exception of the Esquimaux, I remarked, "I think it extremely probable that further investigation will tend to the conclusion that the vertical or flattened occiput, instead of being a typical characteristic, pertains entirely to the class of artificial modifications of the natural cranium familiar to the American ethnologist alike in the disclosures of ancient graves, and in the customs of widely separated living tribes."*

This idea received further confirmation from noticing the almost invariable accompaniment of such traces of artificial modification, with more or less inequality in the two sides of the head. In the extremely transformed skulls of the Flathead Indians, and of the Natchez, Peruvians, and other ancient nations by whom the same barbarous practice was encouraged, the extent of this deformity is frequently such as to excite surprise that it could have proved compatible with the healthful exercise of any vital functions. But the aspect in which it is now purposed to review the subject of artificial modifications of the human cranium, in relation to ancient British skull forms, was suggested, in the same paper above referred to, when pointing out the mistaken idea adopted by Dr Morton, that such unsymmetrical conformation, or irregularity of form, is peculiar to American crania.† The latter remark, I then observed, is too wide a generalisation. I have repeatedly noted the like unsymmetrical characteristics in the brachycephalic crania of Scottish barrows, and it has occurred to my mind, on more than one occasion, whether such may not furnish an indication of some partial compression, dependent, it may be,

* *Edinburgh Philosophical Journal*, n.s., vol. vii. p. 24. *Canadian Journal*, vol. ii. p. 406.

† *Crania Americana*, p. 115. *Types of Mankind*, p. 444.

on the mode of nurture in infancy, having tended, in their case also, if not to produce, to exaggerate the short longitudinal diameter, which constitutes one of their most remarkable characteristics.

The idea thus expressed, in a paper read before the American Scientific Association at Montreal, as well as at the Dublin meeting of the British Association in 1857, was the result of observations made before leaving Scotland in 1853. One chapter of the "*Prehistoric Annals of Scotland*" is devoted to a discussion as to the ethnological significance of the crania of Scottish tumuli; and after its publication I availed myself of every favourable opportunity for adding to the rare materials illustrative of that interesting department. In pursuing such researches my attention was repeatedly drawn to the unsymmetrical proportions of ancient brachycephalic skulls, and to their peculiar truncated form, accompanied, as in the mound skull of the Scioto Valley, by an abrupt flattening of the occiput, which I soon began to suspect was due to artificial causes. Since then the facilities derived from repeated examinations of American collections have familiarised me, not only with the extreme varieties of form of which the human head is susceptible under the influence of artificial compression, but also with the less marked changes undesignedly resulting from such seemingly slight causes as the constant pressure of the Indian cradle-board. The examination and measurement of several hundred specimens of American crania, as well as of the living head in representatives of various Indian tribes, have also satisfied me not only of the existence of dolichocephalic and brachycephalic heads as tribal or national characteristics, but of the common occurrence of the same exaggerated brachycephalic form, accompanied with the vertical or obliquely flattened occiput, which had seemed to be characteristic of the crania of the Scottish tumuli. There are indeed ethnical differences apparent, as in the frontal and malar bones, but so far as the posterior region of the head is concerned, both appear to exhibit the same undesigned deformation resulting from the process of nursing still practised among many Indian tribes.

The light thus thrown on the habits of the British

mother of prehistoric times, by the skull-forms found in ancient barrows, is replete with interest, from the suggestions it furnishes of ancient customs hitherto undreamt of. But it has also another and higher value to the craniologist, from its thus showing that some, at least, of the peculiar forms hitherto accepted as ethnical distinctions, may be more correctly traced to causes operating after birth.

The first example of this peculiar cranial conformation which attracted my attention, as possibly traceable to other causes than the inherited characteristics, or natural deviations from the typical skull-form of an extinct race, occurred on the opening of a stone cist at Juniper Green, near Edinburgh, on the 17th of May 1851. Soon after the publication of the "*Prehistoric Annals of Scotland*," in which the special characteristics of the crania of the Scottish tumuli were first discussed, I heard of the accidental discovery of an ancient tomb in a garden on the Lanark road, a few miles to the north-west of Edinburgh, and immediately proceeded to the spot. The cist occupied a slightly elevated site, distant only a few yards from the road; and as this had long been under cultivation as a garden, if any mound originally marked the spot it had disappeared, and no external indication distinguished it as a place of sepulture. A shallow cist formed of unhewn slabs of sandstone enclosed a space measuring three feet eleven inches in length, by two feet one inch in breadth at the head, and one foot eleven inches at foot. The joints fitted to each other with sufficient regularity to admit of their being closed by a few stone chips inserted at the junction, after which they appeared to have been carefully cemented with wet loam or clay. The slab which covered the whole projected over the sides, so as effectually to protect the sepulchral chamber from any infiltration of earth. It lay in a sandy soil, within little more than two feet of the surface; but it had probably been covered until a comparatively recent period by a greater depth of earth, as its site was higher than the surrounding surface, and possibly thus marked the traces of the nearly levelled tumulus. Slight as this elevation was it had proved sufficient to prevent the lodgment of water, and hence the cist was found perfectly free from damp. With-

in this a male skeleton lay on its left side. The arms appeared to have been folded over the breast, and the knees drawn up so as to touch the elbows. The head had been supported by a flat water-worn stone for its pillow; but from this it had fallen to the bottom of the cist, on its being detached by the decomposition of the fleshy ligatures; and, as is common in crania discovered under similar circumstances, it had completely decayed at the part in contact with the ground. A portion of the left side is thus wanting; but with this exception the skull was not only nearly perfect when found, but the bones were solid and heavy; and the whole skeleton appeared to me so well preserved as to have admitted of articulation. Above the right shoulder, a neat earthen vase had been placed, probably with food or drink. It contained only a little sand and black dust when recovered, uninjured, from the spot where it had been deposited by affectionate hands many centuries before, and is now preserved along with the skull in the Scottish Museum of Antiquities.

As the peculiar forms of certain skulls, such as are described by Dr Thurnam, from an Anglo-Saxon cemetery at Stone, in Buckinghamshire,* and another, described by me, from an Indian cemetery at Montreal,† as well as those of numerous distorted crania, from the Roman site of Uriconium and other ancient cemeteries, have been ascribed to posthumous compression, the precise circumstances attendant on the discovery of the Juniper Green cist are important, from the proof they afford that the body originally deposited within it had lain there undisturbed and entirely unaffected by any superincumbent pressure from the day of its interment. Two, if not three, classes of skulls have been recovered from early British graves. One with a predominant longitudinal diameter, in the most marked examples differs so essentially in its elongated and narrow forehead and occiput from the modern dolichocephalic head, that I was led to assign it to a separate class under the title kumbecephalic.‡ Another has the longitudinal diameter little

* *Crania Britannica*, Dec. i. p. 38.

† *Edin. Phil. Journal*, n. s., vol. xvi. p. 269.

‡ *Prehistoric Annals of Scotland*, p. 177.

in excess of the greatest parietal breadth, and is no less strikingly distinguished from the prevailing modern head, whether of Celtic or Saxon areas, by its shortness, than the other is by its length, when viewed either in profile or vertically. The Anglo-Saxon type of skull appears to be intermediate between those two forms, with a more symmetrical oval, such as is of common occurrence in modern English heads.

If cranial conformation has any ethnical significance, it appears to me inconceivable that the two extreme forms above referred to can both pertain to the same race; and the circumstances under which the most characteristic examples of the opposite types have been found, confirm me in the belief which I advocated when the evidence was much less conclusive, that the older dolichocephalic or kumbecephalic skull illustrates the physical characteristics of a race which preceded the advent of the Celtæ in Britain, and gradually disappeared before their aggressions. As, however, the opposite opinion is maintained by so high an authority as Dr J. Barnard Davis, the comparison of the following measurements, illustrative of the three types of head, will best exhibit the amount of deviation in opposite directions from the intermediate form. The measurements are taken from those furnished in the "*Crania Britannica*," and include the *longitudinal diameter, frontal, parietal, and occipital breadth, parietal height, and horizontal circumference*. No. 1, like the majority of the same class, is derived from a megalithic chambered barrow, and has been selected by Dr Davis as a characteristic example of the class to which it belongs;* though, according to him, that is one of aberrant deviations from the typical British form. No. 2, obtained from a barrow at Codford, in Wiltshire, has also been selected by Dr Davis as one of three typical British crania. It is of the same type as the Juniper Green skull, and its strongly marked characteristics are thus defined by him: "Its most interesting peculiarities are its small size, and its decidedly brachycephalic conformation. This latter character, which commonly appertains to the ancient British cranium, and even to that form which we regard as typical,

* Proceedings of the Acad. Nat. Sciences, Philadelphia, 1857, p. 42.

is seldom met with expressed in so marked a manner.”* No. 3, is a skull from an Anglo-Saxon cemetery near Litlington, Sussex, one of two of which Dr Davis remarks,—“ There is a general indication of good form in these fine capacious skulls, which is apparent in every aspect. . . . On a review of the whole series of Anglo-Saxon crania which have come under our notice, we are led to conclude that this pleasing oval, rather dolichocephalic form, may best be deserving the epithet of typical among them.”† All the three examples are male skulls:—

	L. D.	F. B.	P. B.	O. B.	P. H.	H. C.
1. Uley Chambered Barrow Skull....	8·1	4 7	5 7	5·	5·1	21·7
2. Codford Skull.....	6·8	4 6	5 7	5·1	4·7	20·
3. Litlington Skull.....	7·5	4 7	5·3	4·6	4 9	20·9

Each of the above examples presents the features of the type to which it belongs with more than usual prominence, so that if the mean of a large series were taken, the elements of difference between the three would be less strongly defined. The differences are, however, those on which their separate classification depends, and they thus illustrate the special points on which any craniological comparison for ethnological purposes must be based. Of the three skulls, the era and race of one of them (No. 3) are well determined. It is that of a Saxon, probably of the seventh or eighth century, of the race of the South Saxons, descended from Ælla and his followers, and recovered in a district where the permanency of the same ethnic type is illustrated by its predominance among the rural population at the present day. Another of the selected examples (No. 2) is assumed by Dr Davis, probably on satisfactory grounds, to be an ancient British, *i.e.*, Celtic skull. It is indeed a difficulty, which has still to be satisfactorily explained, how it is, that if this brachycephalic type be the true British head-form, no such prevalence of the form is to be found, on modern Celtic areas, as in the case of Saxon

* *Crania Britannica*, Dec. ii. pl. 14.

† *Ibid.* Dec. iv. pls. 39, 40.

Sussex connects the race of its ancient pagan and Christian cemeteries with the Anglo-Saxon population of the present day. The historical race and era with which Dr Davis conceives the barrow-builders of Wiltshire to be connected is thus indicated in the "*Crania Britannica*," "Region of the Belgæ, Temp. Ptolemæi, A.D. 120." The Belgæ of that era—apparently then comparatively recent intruders, and by some regarded as not Celtic, but Germanic—were displaced, if not exterminated; but the modern Britons of Wales are undoubted descendants of British Celts of Ptolemy's age. Though mingling both Saxon and Norman with pure British blood, they probably preserve the native type as little modified by such foreign admixture as that of its supplanters in the most thoroughly Saxon or Anglish districts of England. It is therefore a question of some importance, how far the extreme brachycephalic proportions of the so-called British type may be traceable to other than inherited ethnical characteristics. Meanwhile, turning from this supposed British skull of Roman times to the one derived from Uley chambered barrow, No. 1, the most ancient of the series, and assuming their chronological order to be undisputed, as it appears to be, we find no gradation from an abbreviated to an elongated form, but, on the contrary, an extreme brachycephalic type interposed between the ovoid dolichocephalic Anglo-Saxon of the Christian era and the extreme dolichocephalic, or kumbecephalic one belonging to a period seemingly so remote, that Dr Thurnam, when noting the recurrence of the same type in another chambered barrow at Littleton Drew, Wiltshire, remarked, "It is not necessary to admit the existence of any pre-Celtic race, as the skulls described may be those of Gaelic, as distinguished from Cymric, Celts; or the long-headed builders of these long, chambered, stone barrows, may have been an intrusive people, who entered Britain from the south-west. Can they have been some ancient Iberian or Ibero-Phœnician settlers?"*

Among the rarer crania of the Morton collection is one to which a peculiar interest attaches, and which may possibly have some significance in reference to this inquiry. Its history is narrated in Dr Henry S. Paterson's

* *Crania Britannica*, Dec. iii. pl. 24 (4).

Memoir of Dr Morton. During a visit of Mr Gliddon to Paris in 1856, he presented a copy of the "*Crania Ægyptiaca*" to the celebrated oriental scholar M. Fresnel, and excited his interest in the labours of its author. Upwards of a year after he received at Philadelphia a box containing a skull, forwarded from Naples, but without any information relative to it. "It was handed over to Morton," says Dr Paterson, "who at once perceived its dissimilarity to any in his possession. It was evidently very old, the animal matter having almost entirely disappeared. Day after day would Morton be found absorbed in its contemplation. At last he announced his conclusion. He had never seen a Phœnician skull, and he had no idea where this one came from, but it was what he conceived a Phœnician skull should be, and it could be no other."* Six months afterwards, Mr Gliddon received, along with other letters and papers forwarded to him from Naples, a slip of paper, in the handwriting of M. Fresnel, containing the history of the skull, which had been discovered by him during his exploration of an ancient rock-tomb at Malta. Dr Meigs refers to this in his catalogue of the collection, No. 1352, as an illustration of "the wonderful power of discrimination, the *tactus visus* acquired by Dr Morton in his long and critical study of craniology." Such was my own impression on first reading it; but I confess the longer I reflect on it, the more am I puzzled to guess by what classical or other data, or process short of absolute intuition, the ideal type of the Phœnician head could be determined. I suspect, therefore, if we had the statement in Dr Morton's own words, it would fall short of such an absolute craniological induction. The following is the sole entry made by him in his catalogue: "Ancient Phœnician? I received this highly interesting relic from M. F. Fresnel, the distinguished French archæologist and traveller, with the following memorandum, A.D. 1847:—Crâne provenant des caves sépulchrales de Ben-Djemma, dans l'île de Malte. Ce crâne paraît avoir appartenu à un individu de la race qui, dans les temps les plus anciens, occupait la côté septentrionale de l'Afrique, et les îles adjacentes." The skull is not im-

* Memoir of Dr S. G. Morton; Types of Mankind, pl. xl.

probably what it has been assumed to be, and it is in many respects a remarkable one. A deep indentation at the nasal suture gives the idea of an overhanging forehead; but the superciliary ridges are not prominent, and the peculiar character of the frontal bone is most strikingly apparent in the vertical view, where it is seen to retreat on either side almost in a straight line from the centre of the glabella to the external angular process of the frontal bone. The contour of the coronal region is described by Dr Meigs as "a long oval, which recalls to mind the kumbecephalic form of Wilson."* Whatever, indeed, be the ultimate conclusion of ethnologists as to the evidences which led me to adopt that name to distinguish the characteristics of a pre-Celtic British race, the necessity appears to be acknowledged for some such term to distinguish the form in question from the ordinary dolichocephalic type. The head is narrow throughout, with its greatest breadth a little behind the coronal suture, from whence it narrows gradually towards front and rear. The lower jaw is large and massive, but with less of the prognathous development than in the superior maxillary. The skull is, no doubt, that of a woman. The nose has been prominent; but the zygomatic arches are delicate, and the whole face is long, narrow, and tapering towards the chin. The parietals meet at an angle, with a bulging of the sagittal suture, and a slight but distinctly defined pyramidal form running into the frontal bone. The occiput is full, round, and projecting a little more on the left side than the right. The measurements of the skull are as follows:—

Longitudinal diameter, ...	7·4
Parietal diameter, ...	5·1
Frontal diameter, ...	4·
Vertical diameter, ...	5·3
Intermeatoid arch, ...	12·3
Intermastoid arch, ...	15· (?)
Intermastoid line, ...	4·3 (?)
Occipito-frontal arch, ...	14·2
Horizontal circumference, ...	20·2

* Catalogue of Human Crania in the Academy of Nat. Science of Philadelphia, p. 29.

I have been thus particular in describing this interesting skull, because it furnishes some points of comparison with British kumbecephalic crania, bearing on the inquiry, whether we may not thus recover traces of the Phœnician explorers of the Cassiterides in the long-headed builders of the chambered barrows. When contrasting the wide and nearly virgin area with which Dr Morton had to deal, with that embraced in the scheme of the "*Crania Britannica*," I remarked in 1857:—Compared with such a wide field of investigation, the little island home of the Saxons may well seem narrow ground for exploration; but to the ethnologist it is not so. There, amid the rudest traces of primeval arts, he seeks, and probably not in vain, for the remains of primitive European allophylia. There it is not improbable that both Phœnicians and early Greek navigators have left behind them evidences of their presence, such as he alone can discriminate.*

Before, however, we can abandon ourselves to the temptations of so seductive a theory,—which, after all, finds only such support as may be deduced from a certain general analogy of cranial form, and derives no confirmation from the works of art accompanying the remains of the long-headed barrow-builders,—it has to be borne in remembrance that the question is still disputed with reference to this class of British dolichocephalic crania: are they examples of an essentially distinct type, preserving evidence of the characteristics of a different race, or are they mere exceptional aberrant deviations from the supposed brachycephalic Celtic or British type? Much stress is laid on the fact that the two forms of skull have occasionally been recovered from the same barrow; from which it may be inferred that the two races to which I conceive them to have belonged, were for a more or less limited period contemporaneous. More than this I cannot regard as a legitimate induction from such premises, in relation to crania of such extremely diverse types. But this amounts to little; for the same is undoubtedly true of the ancient British and the modern Anglo-Saxon race; and the discovery of Celtic and Saxon

* Canadian Journal, vol. ii. p. 445.

skulls in a common barrow or tumulus of the sixth century is no proof that the latter race was not preceded by many centuries in the occupation of the country by the Britons, among whom they then mingled as conquerors and supplanters. But the elongated skulls are no rare and exceptional forms. They have been most frequently found in tombs of a peculiar character, and of great antiquity. Many have been recovered in too imperfect a state to admit of more being deduced from the fragments than that these conform to the more perfect examples of the peculiar type. Nevertheless the number already obtained in a sufficiently perfect state to admit of detailed measurement is remarkable, when their great age and the circumstances of their recovery are fully considered. Of this the following enumeration will afford satisfactory proof. Only two perfect crania from the chambered tumulus of Uley, in Gloucestershire,—of which the proportions of one are cited above,—have been preserved. But in the later search of Mr Freeman and Dr Thurnam, in 1854, the fragments of eight or nine other skulls were recovered, and of these the latter remarks: “The fragments are interesting, as proving that the characters observed in the more perfect crania were common to the individuals interred in this tumulus. Three or four calvaria are sufficiently complete to show that in them likewise the length of the skulls had been great in proportion to the breadth.”* Again, in the megalithic tumulus of Littleton Drew, North Wilts, at least twenty-six skeletons appear to have been found, from several of which imperfect crania were recovered, and of those Dr Thurnam remarks: “Eight or nine crania were sufficiently perfect for comparison. With one exception, in which a lengthened oval form is not marked, they are of the dolichocephalic class.”† So also the four nearly perfect skulls from West Kennet are described as “more or less of the lengthened oval form, with the occiput expanded and projecting, and presenting a strong contrast to skulls from the circular barrows of Wilts and Dorset.”‡ To these may be added those of Stoney Little-

* *Archæol. Journal*, vol. xi. p. 313. *Crania Britannica*, Dec. i. pl. 5.

† *Crania Britannica*, Dec. iii. pl. 24 (3).

‡ *Ibid.* Dec. v. pl. 50 (4).

ton, Somersetshire, first pointed out by Sir R. C. Hoare;* and examples from barrows in Derby, Stafford, and Yorkshire, described by Mr Thomas Bateman in his "Ten Years' Diggings in Celtic and Saxon Grave Hills;" including those from Bolehill, Longlow, and Ringham Low, Derbyshire; from the galleries of the tumulus on Five-Wells Hill, and from the Yorkshire barrow near Heslerton-on-the-wolds. Several of the above contained a number of skulls; and of the last, in which fifteen human skeletons lay heaped together, Mr Bateman remarks: "The crania that have been preserved are all more or less mutilated; but about six remain sufficiently entire to indicate the prevailing conformation to be of the long or kumbecephalic type of Dr Wilson."† The crania occurring in graves of this class mentioned by Mr Bateman alone, exceed fifty in number, of which the majority are either of the elongated type, or too imperfect to be determined. The others include between thirty and forty well-determined examples, besides a greater number in too imperfect a state to supply more than indications of their correspondence to the same characteristic form. Alongside of some of these are also found brachycephalic crania; but in the most ancient barrows the elongated skull appears to be the predominant, and in some cases the sole type; and of the examples found in Scotland, two have been recovered from peat bogs, and others under circumstances more definitely marking their great antiquity.

The variations of cranial form are thus, it appears, no gradual transition, or partial modification, but an abrupt change from an extreme dolichocephalic to an extreme brachycephalic type; which, on the intrusion of the new and essentially distinct Anglo-Saxon race, gives place once more to a dolichocephalic form of medium proportions.

Leaving, meanwhile, the consideration of the question of distinct races indicated by such evidence, it will be well to determine first if such variations of skull-form can be traced to other than a transmitted ethnical source. The Juniper Green skull, already referred to, presents in profile, as shown in the full-sized view in the "*Crania Britannica*,"

* *Archæologia*, vol. xix. p. 47.

† *Ten Years' Diggings in Celtic and Saxon Grave Hills*, p. 230.

the square and compact proportions characteristic of British brachycephalic crania. It also exhibits, in the vertical outline, the truncated wedge form of the type. In the most strongly marked examples of this form, the vertical or flattened occiput is a prominent feature, accompanied generally with parietal breadth, from which it abruptly narrows at the occiput. The proportions of this class of crania were already familiar to me before the discovery of the Juniper Green example ; but it had not before occurred to me to ascribe any of their features to other than natural causes. But the circumstances attending its discovery gave peculiar interest to whatever was characteristic in the skull and its accompanying relics, handled for the first time as evidences of the race and age of the freshly-opened cist, discovered almost within sight of the Scottish capital, and yet pertaining to prehistoric times. The skull was carried home in my hand, a distance of several miles, and its truncated outline, and still more, its flattened occiput, attracted special attention, and gave rise to conversation with my friend Mr Robert Chambers, who had accompanied me on this exploratory excursion. With the temptation of a novel discovery, I was at first disposed to recognise the traces of art in this abbreviated form, not only as exaggerating the natural characteristics, but as a possible source of their production. But a comparison with examples of the true dolichocephalic skull, to which I had already assigned priority in point of time, sufficed to dispel that illusion. At a subsequent meeting of the Society of Antiquaries of Scotland, I accompanied the presentation of the cranium and urn with an account of the circumstances of their discovery, and some remarks on the novel features noticeable in the skull. Unfortunately the printing of the Society's Proceedings, which had been suspended for some time, was not resumed till the following season ; and no record of this communication was preserved beyond the title.

Another skull in the same collection, found under somewhat similar circumstances in a cist at Lesmurdie, Banffshire, has the vertical occiput accompanied by an unusual parietal expansion and want of height, suggestive of the

idea of a combined coronal and occipital compression.* A third Scottish skull, procured from one of a group of cists near Kinaldie, Aberdeenshire, also exhibits the posterior vertical flattening. But a more striking example than any of those appears in the one from Codford, South Wiltshire, selected above to illustrate this type.† Dr Davis remarks in his description of it:—"The zygomatic arches are short, a character which appertains to the entire calvarium, but is most concentrated in the parietals, to which the abruptly ascending portion of the occipital lends its influence. The widest part of the calvarium is about an inch behind, and as much above the auditory foramen, and when we view it in front we perceive it gradually to expand from the outer angular process of the frontal to the point now indicated." The entire parieto-occipital region presents in profile an abrupt vertical line; but when viewed vertically it tapers considerably more towards the occiput than is usual in crania of the same class.

The cause of the vertical occiput, as well as the oblique parieto-occipital flattening in this class of British crania, I feel no hesitation in believing to be traceable to the same kind of rigid cradle-board as is in constant use among many of the Indian tribes of America, and which produces precisely similar results. Its mode of operation, in effecting the various forms of oblique and vertical occiputs, will be considered, when describing some of the phenomena of compressed Indian crania; but another feature of the Juniper Green skull, which is even more obvious in that from Lesmurdie, in the same collection, is an irregularity amounting to a marked inequality in the development of the two sides. This occurs in skulls which have been altered by posthumous compression; but the recovery of both the examples referred to from stone cists precludes the idea of their having been affected by the latter cause; and since I was first led to suspect the modification of the occiput, and the exaggeration of the characteristic proportions of British brachycephalic crania by artificial means, familiarity with those of the Flathead Indians, as well as other ancient and modern artificially distorted American crania, has led me

* *Crania Britannica*, Dec. ii. pl. 16.

† *Ibid.* Dec. ii. pl. 14.

to recognise in their parietal conformation the constant occurrence of the same unsymmetrical inequality.

But besides the well-known distortions produced in many American crania by protracted compression purposely applied with a view to change the form, others of a less marked character closely correspond to those of the British brachycephalic crania. The normal human head may be assumed to present a perfect correspondence in its two hemispheres; but very slight investigation will suffice to convince the observer that few living examples satisfy the requirements of such a theoretical standard. Not only is inequality in the two sides frequent, but a perfectly symmetrical head is the exception rather than the rule. The plastic condition of the cranial bones in infancy, which admits of all the strange malformations of ancient Macrocephali and modern Flatheads, also renders the infant head liable to many undesigned changes. From minute personal examination I have satisfied myself of the repeated occurrence of inequality in the two sides of the head, arising from the mother being able to suckle her child only at one breast, so that the head was subjected to a slight but constantly renewed pressure in the same direction. It is surprising, indeed, to how great an extent such unsymmetrical irregularity is found to prevail, when once the attention has been drawn to it. The only example of the Greek head possessed by Dr Morton, was a cast presented to him by Dr Retzius, and which, from its selection by the distinguished Swedish craniologist for such a purpose, might reasonably be assumed to illustrate the Greek type. It is accordingly described by Dr J. Aitken Meigs, in his "Cranial Characteristics of the Race of Man," as very much resembling that of Constantine Demetriades, a Greek native of Corfu, and long a teacher of the modern Greek language at Oxford, as engraved in Dr Prichard's *Researches*. Its cranial characteristics are thus defined in the Catalogue of the Mortonian Collection (No. 1354): "The calvarial region is well developed, the frontal line expansive and prominent, the facial line departs but slightly from the perpendicular." On recently visiting Philadelphia for the purpose of renewed examination of its valuable collections, I was surprised to

find this head, instead of being either oval, or, as Blumenbach describes the example selected by him, subglobular: presenting the truncated form, with extreme breadth at the parietal protuberances, and then abruptly passing to a flattened occiput. It measures 6·5 longitudinal diameter; 5·7 parietal diameter; and 19·2 horizontal circumference. But the most noticeable feature is the great inequality of the two sides, the right side is less tumid than the left, while it projects more to the rear, and the whole is fully as unsymmetrical as many American crania. Were it not that this feature appears to have wholly escaped Dr Morton's attention, as he merely enters it in his catalogue as a "Cast of the skull of a young Greek. Professor Retzius," I should be tempted to suppose it had been purposely sent to him to illustrate the phenomena of unsymmetrical development, and of the influence of undesigned artificial causes on skull-forms. Nor was Dr Morton unobservant of such indications. When first noticing the probable origin of the flattened occiput of certain British skulls, I drew attention to the fact, that he had already recognised undesigned artificial compression as one source of abnormal cranial conformation, and accompanied its demonstration with a reference to the predominant unsymmetrical form in all such skulls. "This irregularity," he added, "chiefly consists in the greater projection of the occiput to one side than the other," and "is not to be attributed to the intentional application of mechanical force." Such want of uniformity in the two sides of the head is much more strongly marked in Flathead skulls, which have been subjected to great compression. It is clearly traceable to the difficulty of subjecting the living and growing head to a perfectly uniform and equable pressure, and to the cerebral mass forcing the skull to expand with it in the direction of least resistance. Hence the unsymmetrical form accompanying the vertical occiput in the Lesmurdie and Juniper Green skulls, and, as I conceive also, in the Greek skull of Retzius. The study of the latter skull-form has tended strongly to confirm me in the belief, that the extreme abbreviated proportions of many naturally brachycephalic crania are due to artificial causes. Wherever a very noticeable inequality exists between the two sides,

it may be ascribed with much probability to the indirect results of designed or accidental compression in infancy ; and by its frequent occurrence in any uniform aspect, may, quite as much as the flattened occiput, furnish a clue to customs or modes of nurture among the people to whom it pertains.

Dr Struthers of Edinburgh has in his collection an interesting example of a modern skull, measuring 7·5 longitudinal diameter, 6·5 parietal diameter, 21·4 horizontal circumference, in which the truncated form is even more strongly marked by the abrupt flattening, immediately behind the parietal protuberances, accompanied with inequality in the two sides of the head. It was obtained from a grave-digger in Dundee, who stated it to be that of a middle-aged female, whom he had known during life. There was nothing particular about her mental development.

I have also drawn attention in former papers to the fact that such peculiar forms and examples of inequality in the development of the two sides of the head are familiar to hat-manufacturers. Occasionally the eye is attracted by very unusual cranial forms revealed by baldness ; but the hair suffices generally to conceal abnormal irregularities, some of which, as illustrated by hatters' shapes, are extremely odd and fantastical. My attention was directed to this familiar test by a remark of the late Dr Kombst, that he had never been able to obtain an English-made hat that would fit his head. He added, that he believed such was the general experience of Germans, owing to the greater length of the English head. I subsequently found the shapes of a Yorkshire hatter to be shorter than some furnished me from Dublin ; while English and Anglo-Canadian ones are decidedly longer than those of the French Canadians of Lower Canada ; and I believe that comparisons of the shapes most in demand in different parts of the British Islands, and on the Continent, will supply important cranio-logical results.

The novel forms thus occurring in modern heads, though chiefly traceable, as I believe, to artificial causes, are not the result of design. But the same is true of the prevalent vertical and obliquely flattened occiput of many ancient and

modern American crania, as well as of the British brachycephalic class already described. Nor are such changes of the natural form necessarily limited to skulls of short longitudinal diameter, in which this typical characteristic is exaggerated by the pressure of the cradle-board in infancy. Now that this source of modification begins to receive general recognition among craniologists, its influence is assumed as a probable source of the most diverse aberrant forms. Dr Thurnam, when referring to two skulls of different shapes, recovered from the same group of British barrows, of "a somewhat late though pre-Roman period," on Roundway Hill, North Wiltshire, thus indicates their contrasting characteristics, and suggests the probable source of such divergence from the supposed British type: "The general form of the cranium (plate 43) differs greatly from that from the adjoining barrow (plate 42). That approaches an acrocephalic, this a platycephalic form; that is eminently brachycephalic, this more nearly of a dolichocephalic character. As the eye at once detects, the difference is much greater than would be inferred from a mere comparison of the measurements. The respective peculiarities of form in the two skulls may possibly be explained by supposing that both have been subject to artificial deformation, though of a different kind,—the one appearing to have been flattened on the occiput, the other showing a depression immediately behind the coronal suture over the parietal bones, which seems to indicate that this part of the skull was subject to some habitual pressure and constriction, perhaps from the use of a bandage or ligature tightly bound across the head and tied under the chin, such as to this day is employed in certain parts of the west of France, producing that form of distortion named by Dr Gosse the *sincipital*, or *tête bilobée*."*

The influence of the recognition of this source of change is, indeed, very manifest throughout the fifth Decade of the "Crania Britannica." An extremely brachycephalic skull of a youth, obtained from a barrow on Ballard Down, Isle of Purbeck, is described as unsymmetrical, and as affording "tolerably clear evidence that this form, if not always produced, was at least liable to be exaggerated by an artificial

* *Crania Britannica*, Dec. v. pl. 43.

flattening of the occiput, such as is practised by many American and Polynesian tribes.”* In the same Decade another skull of the type most dissimilar to this is described and illustrated. It was recovered in fragments from the remarkable chambered barrow at West Kennet, Wiltshire, and its most characteristic features are thus defined by Dr Thurnam:—“It is decidedly dolichocephalic, narrow, and very flat at the sides, and realises more nearly than any we have yet had to figure the kumbecephalic or boat-shaped form described by Dr D. Wilson. The frontal region is narrow, moderately arched, and elevated at the vertex, but slopes away on each side. The parietal region is long, and marked by a prominent ridge or *carina* in the line of the sagittal suture, which is far advanced towards obliteration, whilst the other sutures are quite as perfect as usual. The occiput is full and prominent; the supra-occipital ridges only moderately marked. There is a deep digastric groove, and a slight paroccipital process on each side. The external auditory openings are somewhat behind the middle of the skull, and very much behind a vertical line drawn from the junction of the coronal and sagittal sutures.” Its extreme length and breadth are 7·7 and 5·1, and an inequality in the development of the two sides is obvious in the vertical view. As the brachycephalic skull recalls certain American and Polynesian forms, so such examples of the opposite type suggest the narrow and elongated skulls of the Australians and Esquimaux; and he thus proceeds:—“The Ballard Down skull bears marks of artificial flattening of the occiput; this calls to mind the artificial lateral flattening of the skull, characteristic of the ancient people called Macrocephali, or long-heads, of whom Hippocrates tells us, that ‘while the head of the child is still tender, they fashion it with their hands, and constrain it to assume a lengthened shape by applying bandages and other suitable contrivances, whereby the spherical form of the head is destroyed, and it is made to increase in length.’ This mode of distortion is called by Dr Gosse the *temporo-parietal*, or ‘*tête aplatie sur les côtés*.’ It appears to have been practised by various people, both of the ancient and modern world, and in Europe as well as the

* Crania Britannica, Dec. v. pl. 45.

East. The so-called Moors, or Arabs of North Africa, affected this form of skull; and even in modern times, the women of Belgium and Hamburg are both described as compressing the heads of their infants into an elongate form. Our own observations lead at least to a presumption that this form of artificial distortion may have been practised by certain primeval British tribes, particularly those who buried their distinguished dead in long chambered tumuli." Accordingly, Dr Thurnam draws attention to the obliteration of the sagittal suture, both in the skull in question, and to a still greater extent in one figured by Blumenbach, under the name of "Asiatic Macrocephali," and expresses his belief that this "has been produced by pressure or manipulations of the sides of the head in infancy, by which it was sought to favour the development of a lengthened form of skull; to which, however, there was probably, in the present instance, at least, a natural and inherent tendency."

It thus appears that a class of variations of the form of the human skull, which becomes more comprehensive as attention is directed to it, is wholly independent of congenital transmitted characteristics: kumbecephalic, acrocephalic, and platycephalic, unsymmetrical, truncated, or elongated heads, may be so common as apparently to furnish distinctive ethnical forms, and yet, after all, each may be traceable to artificial causes, arising from an adherence to certain customs and usages in the nursery. It is in this direction, I conceive, that the importance of the truths resulting from the recognition of artificial causes affecting the forms of British brachycephalic or other crania chiefly lies. The contents of early British cists and barrows prove that the race with whom they originated was a rude people, ignorant, for the most part, of the very knowledge of metals, or at best in the earliest rudimentary stage of metallurgic arts. They were, in fact, in as uncivilised a condition as the rudest forest Indians of America. To prove, therefore, that, like the Red Indian squaw, the British allophylian or Celtic mother formed the cradle for her babe of a flat board, to which she bound it, for safety and facility of nursing, in the vicissitudes of her nomade life,—though interesting, like every other recovered glimpse of a long-forgotten past,—

is not in itself a discovery of much significance. But it reminds us how essentially man, even in the most degraded state of wandering savage life, differs from all other animals. The germs of an artificial life are there. External appliances, and the conditions which we designate as domestication in the lower animals, appear to be inseparable from him. The most untutored nomades subject their offspring to many artificial influences, such as have no analogy among the marvellous instinctive operations of the lower animals. It is not even unworthy of notice that man is the only animal to whom a supine position is natural for repose; and with him more than any other animal, when recumbent, the head is necessarily placed so as to throw the greatest pressure on the brain-case, and not on the malar or maxillary bones. Without, therefore, running to the extreme of Dr Morton, who denied, for the American Continent, at least, the existence of any true dolichocephalic crania, or, indeed, any essential variation from one assumed typical form, it becomes an important point for the craniologist to determine, if possible, to what extent certain characteristic diversities may be relied upon as the inherited features of a tribe or race; or whether they are not the mere result of artificial causes originating in long perpetuated national customs and nursery usages. If the latter is, indeed, the case, then they pertain to the materials of archæological rather than of ethnological deduction, and can no longer be employed as elements of ethnical classification.

Every scheme of the craniologist for systematising ethnical variations of cranial configuration, and every process of induction pursued by the ethnologist from such data, proceed on the assumption that such varieties in the form of cranium are constant within certain determinate limits, and originate in like natural causes with the features by which we distinguish one nation from another. By like means the comparative anatomist discriminates between the remains of the *Bos primigenius*, the *Bos longifrons*, and other kindred animal remains, frequently found alongside of the human skeleton, in the barrow; and, by a similar crucial comparison, the craniologist aims at classifying the crania

of the ancient Briton, Roman, Saxon, and Scandinavian, apart from any aid derived from the evidence of accompanying works of art. But if it be no longer disputable that the human head is liable to modification from external causes, so that one skull may have been subjected to lateral compression, resulting in the elongation and narrowing of its form; while another, under the influence of occipital pressure, may exhibit a consequent abbreviation in its length, accompanied by parietal expansion; it becomes indispensable to determine some data whereby to eliminate this perturbing element before we can ascertain the actual significance of national skull-forms. If, for example,—as appears to be the case,—the crania from British graves of Roman times reveal a different form from that of the modern Celtic Briton, the cause may be an intermixture of races, like that which is clearly traceable among the mingled descendants of Celtic and Scandinavian blood in the north of Scotland; but it may also be, in part or wholly, the mere result of a change of national customs following naturally on conquest, civilisation, and the abandonment of Paganism for Christianity.

It is in this respect that the artificial causes tending to alter the natural conformation of the human head invite our special study. They appear at present purely as disturbing elements in the application of craniological tests of classification. It is far from improbable, however, that, when fully understood, they may greatly extend our means of classification, so that when we have traced to such causes certain changes in form, in which modern races are known to differ from their ethnical precursors, we shall be able to turn the present element of disturbance to account, as an additional confirmation of truths established by inductive craniology. Certain it is, however, whatever value may attach to the systematising of such artificial forms, that they are of frequent occurrence, apart altogether from such configuration as is clearly referrible to the application of mechanical pressure in infancy with that express object in view; or again, as is no less obviously the result of post-humous compression. But though the deforming processes designedly practised among ancient and modern savage

nations lie beyond the direct aim of the present inquiry, they are calculated to throw important light on the approximate results of undesigned compression and arrested development.

Among the flathead Indian tribes of Oregon and the Columbia River, where malformation of the skull is purposely aimed at, the infant's head is tightly bound in a fixed position, and maintained under continuous pressure for months. But it is a mistake to suppose that in the ordinary use of the cradle-board the Indian pappoose is subject to any such extreme restraint. The objects in view are facility of nursing and transport, and perfect safety for the child. But those being secured, it is nurtured with a tenderness of maternal instinct surpassing that of many savage nations. The infant is invariably laid on its back, but the head rests on a pillow or mat of moss or frayed bark, and is not further restrained in a fixed position than necessarily results from the posture in which the body is retained by the bandages securing it in the cradle. This fact I have satisfied myself of from repeated observations. But the consequence necessarily is, that the soft and pliant bones of the infant's head are subjected to a slight but constant pressure on the occiput during the whole protracted period of nursing, when they are peculiarly sensitive to external influences. Experiments have shown that at that period the bones specially affected by the action of the cradle-board are not only susceptible of changes, but liable to morbid affections dependent on the nature of the infant's food. Lehmann supposes the Craniotabes of Elsässer to be a form of rachitis, which affects the occipital and parietal bones during the period of suckling; and Schlossberger ascertained by a series of analyses of such bones, that the 63 per cent. of mineral constituents found in the normal occipital bones of healthy children during the first year diminished to 51 per cent. in the thickened and spongy bone.* The fluctuations in proportion of the mineral constituents of bones are considerable, and vary in the different bones, but in the osseous tissue they may be stated at from

* Schlossberger, *Arch. l. phys. Heilk.* Lehmann, *Physiol. Chem.*, vol. iii. p. 28.

67 to 70 per cent. It is obvious, therefore, that under the peculiar physiological condition of the cranial bones during the period of nursing, such constant mechanical action as the occiput of the Indian pappoose is subjected to must be productive of permanent change. The child is not removed from the cradle-board when sucking, and is not therefore liable to any counteracting lateral pressure against its mother's breast. One effect of such continuous pressure must be to bring the edges of the bones together, and thereby to retard or arrest the growth of the bone in certain directions. The result of this is apparent in the premature ossification of the sutures of artificially deformed crania.

At Washington I had an opportunity of minutely examining thirty-four Flathead skulls brought home by the United States Exploring Expedition, some of them presenting the most diverse forms of distortion. In the majority of those, the premature ossification of the sutures is apparent, and in some they are almost entirely obliterated. The same is no less obvious among the corresponding class in the collection of the Academy of Natural Sciences of Philadelphia, and especially in skulls of the Chinooks, who carry the process of deformation to the greatest extent. But I have also been struck, not only with the frequent occurrence of wormian bones in such altered skulls, but also with the distinct definition of a true supraoccipital bone.

It is marvellous to see the extraordinary amount of distortion to which the skull and brain may be subjected without seemingly affecting either health or intellect. The coveted deformity is produced partly by actual compression, and partly by the growth of the brain and skull being thereby limited to certain directions. Hales, the ethnographer of the exploring expedition, after describing the process as practised among the Chinooks, remarks: "The appearance of the child when just released from this confinement is truly hideous. The transverse diameter of the head above the ears is nearly twice as great as the longitudinal from the forehead to the occiput. The eyes, which are naturally deep set, become protruding, and appear as if squeezed partially out of the head."* Mr Paul Kane, in

* Ethnography of the U. S. Exploring Expedition, p. 216.

describing to me the same appearance, as witnessed by him on the Columbia River, compared the eyes to those of a mouse strangled in a trap. The appearance is little less singular for some time after the child has been freed from the constricting bandages, as shown in an engraving from one of Mr Kane's sketches of a Chinook child seen by him at Fort Astoria.* In after years, the brain, as it increases, partially recovers its shape; and in some of the deformed adult skulls, one suture gapes while all the rest are ossified, and occasionally a fracture or false suture remains open. An adult skull, of the same extremely deformed shape, among those brought home by the Exploring Expedition, illustrates the great extent to which the brain may be subjected to compression and malformation without affecting the intellect. It is that of a Nasqually chief, procured from his canoe-bier in Washington Territory. (No. 4549.) The internal capacity, and consequent volume of brain, is 95 cubic inches. The head is compressed into a flattened disc, with the forehead receding in a straight line from the nasal suture to the crown of the head, while the lambdoidal suture is on the same plane with the *foramen magnum*. The sutures are nearly all completely ossified, and the teeth ground quite flat, as is common with many of the tribes in the same region, and especially with the Wallawalla Indians on the Columbia River, who live chiefly on salmon dried in the sun, and invariably impregnated with the sand which abounds in the barren waste they occupy. I assume the unimpaired intellect of the Nasqually chief from his rank. The Flathead tribes are in the constant habit of making slaves of the round-headed Indians; but no slave is allowed to flatten or otherwise modify the form of her child's head, that being the badge of Flathead aristocracy. As this has been systematically pursued since ever the tribes of the Pacific coast were brought under the notice of Europeans, it is obvious that if such superinduced deformity developed any general tendency to cerebral disease, or materially affected the intellect, the result would be apparent in the degeneracy or extirpation of the Flathead tribes. But so far is this from being the case, that

* Prehistoric Man, vol. ii. p. 320.

they are described by traders and voyagers as acute and intelligent. They are, moreover, an object of dread to neighbouring tribes who retain the normal form of head, and look on the latter with contempt, as thus bearing the hereditary badge of slaves.

The child born to such strange honours is laid, soon after its birth, upon the cradle-board, an oblong piece of wood, sometimes slightly hollowed, and with a cross-board projecting beyond the head to protect it from injury. A small pad of leather, stuffed with moss or frayed cedar bark, is placed on the forehead and tightly fastened on either side to the board, and this is rarely loosed until its final removal before the end of the first year. The skull has then received a form which is only slightly modified during the subsequent growth of the brain. But the very same kind of cradle is in use among all the Indian tribes. It is indeed varied as to its ornamental adjuncts and non-essential details; but practically it resolves itself, in every case, into a straight board to which the infant is bound; and as it is retained in a recumbent position, the pressure of its own weight, during the period when, as has been shown, the occipital and parietal bones are peculiarly soft and compressible, is made to act constantly in one direction. This I assume to have been the cause of the vertical or otherwise flattened occiput in the ancient British brachycephalic crania. The same cause must tend to increase the characteristic shortness in the longitudinal diameter, and to shorten the zygoma, with probably also some tendency to make the arch bulge out in its effort at subsequent full growth, and so to widen the face.

Dr J. Barnard Davis has applied the term "parieto-occipital flatness," where the results of artificial compression in certain British skulls extend over the parietals with the upper portion of the occipital; and he appears to regard this as something essentially distinct from the vertical occiput. But it is a form of common occurrence in Indian skulls, and is in reality the most inartificial of all the results of the undesigned pressure of the cradle-board. This will be understood by a very simple experiment. If the observer lie down on the floor, without a pillow, and then ascertain

what part of the back of the head touches the ground, he will find that it is the portion of the occiput immediately above the lambdoidal suture, and not the occipital bone. When the Indian mother places a sufficiently high pillow for her infant, the tendency of the constant pressure will be to produce the vertical occiput; but where, as is more frequently the case, the board has a mere cover of moss or soft leather, then the result will be just such an oblique parietal flattening as is shown on a British skull from the remarkable tumulus near Littleton Drew, Wiltshire, figured in the "*Crania Britannica*," Decade iii., plate 24.

But there are other sources of modification of the human skull in infancy, even more common than the cradle-board. More than one of the predominant head-forms in Normandy and Belgium are now traced to artificial changes, and by many apparently trifling and unheeded causes, consequent on national customs, nursing usages, or the caprices of dress and fashion, the form of the head may be modified in the nursery. The constant laying of the infant to rest on its side, the pressure in the same direction in nursing it, along with the fashion of cap, hat, or wrappage, may all influence the shape of head among civilised nations, and in certain cases tend as much to exaggerate the naturally dolichocephalic skull, as the Indian cradle-board increases the short diameter of the opposite type. Such artificial cranial forms as that designated by M. Foville the *Tête annulaire*, may have predominated for many centuries throughout certain rural districts of France, solely from the unreasoning conformity with which the rustic nurse adhered to the traditional or prescriptive bandages to which he ascribes that distortion. All experience shows that such usages are among the least eradicable, and long survive the shock of revolutions that change dynasties and efface more important national characteristics.

But now that attention has been directed to the subject of undesigned changes thus effected on the human head, its full bearings begin to be appreciated; and there is even, perhaps, a danger that more may be ascribed to them than is legitimate. Such was undoubtedly the effect on Dr Morton's mind from his familiarity with the results of artificial de-

formation on American crania ; and were we to follow his example, we should be tempted to designate all the extreme varieties of the elongated dolichocephalic, acrocephalic, and brachycephalic skulls of British barrows, as mere modifications of the same ethnical form. In his latest recorded opinions, when commenting on some of the abnormal forms of Peruvian crania, he remarks : " I at first found it difficult to conceive that the original rounded skull of the Indian could be changed into this fantastic form, and was led to suppose that the latter was an artificial elongation of a head remarkable for its length and narrowness. I even supposed that the long-headed Peruvians were a more ancient people than the Inca tribes, and distinguished from them by their cranial configuration. In this opinion I was mistaken. Abundant means of observation and comparison have since convinced me that all these variously-formed heads were originally of the same shape, which is characteristic of the aboriginal race from Cape Horn to Canada, and that art alone has caused the diversities among them."* The repeated opportunities I have enjoyed of examining the Mortonian and other American collections, have satisfied me of the occurrence of both dolichocephalic and brachycephalic crania, not only as the characteristics of distinct tribes, but also among the contents of the same Peruvian cemeteries,—not as examples of extreme latitudes of form in a common race, but as the results of the admixture either of conquering and subject races, or of distinct classes of nobles and serfs, most generally resulting from the predominance of conquerors.† Among the Peruvians the elongated cranium pertained to the dominant race, and some of the results of later researches in primitive British cemeteries, and especially the disclosures of the remarkable class of chambered barrows, seem to point to an analogous condition of races. That the Uley and West Kennet skulls may have been laterally compressed, while the Codford barrow and other brachycephalic skulls have been affected in the opposite direction, appears equally probable. But such artificial influences only very partially account for the great diversity

* Physical Type of the American Indian. Schoolcraft, p. 326.

† Prehistoric Man, vol. ii. p. 225.

of type; and no such causes, even if brought to bear in infancy, could possibly convert the one into the other form.

But as the cranial forms, both of the Old and New World, betray evidences of modification by such artificial means; so also we find in ancient Africa a diverse form of head, to which art may have contributed, solely by leaving it more than usually free from all extraneous influences. Such at least is the conclusion suggested to my mind from the examination of a considerable number of Egyptian skulls. Among familiar relics of domestic usages of the ancient Egyptians is the pillow designed for the neck, and not the head, to rest upon. Such pillows are found of miniature sizes, indicating that the Egyptian passed from earliest infancy without his head being subjected even to so slight a pressure as the pillow, while he rested recumbent. The Egyptian skull is long, with great breadth and fulness in the posterior region. In its prominent, rounded parieto-occipital conformation, an equally striking contrast is presented to the British brachycephalic skull with truncated occiput, and to the opposite extreme characteristic of the primitive dolichocephalic skull; though exceptional examples are not rare. This characteristic did not escape Dr Morton's observant eye, and is repeatedly indicated in the "*Crania Ægyptiaca*" under the designation "tumid occiput." It also appears to me, after careful examination of the fine collection formed by him, and now in the Academy of Natural Sciences of Philadelphia, that the Egyptian crania are generally characterised by considerable symmetrical uniformity, as was to be anticipated, if there is any truth in the idea of undesigned artificial compression and deformation resulting from such simple causes as the mode of nurture in infancy.

The heads of the Fiji Islanders supply a means of testing the same cause, operating on a brachycephalic form of cranium; as most of the islanders of the Fiji group employ a neck-pillow nearly similar to that of the ancient Egyptians, and with the same purpose in view, that of preserving their elaborately dressed hair from dishevelment. In their case, judging from an example in the collection of the Royal College of Surgeons of London, the occipital region is

broad, and presents in profile a uniform, rounded conformation passing almost imperceptibly into the coronal region. Indeed the broad, well rounded occiput is considered by the Fijians a great beauty. The bearing of this, however, in relation to the present argument, depends on whether or not the Fiji neck-pillow is used in infancy. From the unreasoning uniformity of adherence to any national custom, common to all rude people, it is probable that the same pillow is used for the infant and the adult as among the Egyptians; but I have failed to obtain definite information on this point. In one male Fiji skull brought home by the United States Exploring Expedition (No. 4581), the occiput exhibits the characteristic full, rounded form, with a large and well-defined supra-occipital bone. But in another skull in the same collection that of Veindovi, Chief of Kantavu, who was taken prisoner by the U. S. ship Peacock in 1840, and died at New York in 1842, the occiput, though full, is slightly vertical. The occipital development of the Fiji cranium is the more interesting as we are now familiar with the fact that the artificially flattened occiput is of common occurrence among the islanders of the Pacific Ocean. "In the Malay race," says Dr Pickering, "a more marked peculiarity, and one very generally observable, is the elevated occiput, and its slight projection beyond the line of the neck. The Mongolian traits are heightened artificially in the Chinooks, but it is less generally known that a slight pressure is often applied to the occiput by the Polynesians, in conformity with the Malay standard."* Dr Nott, in describing the skull of a Kanaka of the Sandwich Islands who died at the Marine Hospital at Mobile, mentions his being struck by its singular occipital formation; and this he learned was due to an artificial flattening which the islander had stated to his medical attendants in the hospital was habitually practised in his family.† According to Dr Davis, it is traceable to so simple a cause as the Kanaka mother's habit of supporting the head of her nursling in the palm of her hand.‡ Whatever be the cause, the fact is now well established. The

* Pickering's *Races of Man*, p. 45.

† *Types of Mankind*, p. 436.

‡ *Crania Britannica*, Dec. III. pl. 24 (4).



Figl. L.



Figl. R.



Fig 2.



Fig 3



Fig. 4.



Fig 6.



Fig 5



occipital flattening is clearly defined in at least three of the Kanaka skulls in the Mortonian Collection ; No. 1300, a male native of the Sandwich Islands, aged about forty ; No. 1308, apparently that of a woman, from the same locality ; and in No. 695, a girl of Oahu, of probably twelve years of age, which is markedly unsymmetrical, and with the flattening on the left side of the parietal and occipital bones. The Washington Collection includes fourteen Kanaka skulls ; besides others from various islands of the Pacific, among which several examples of the same artificial formation occur : *e.g.*, No. 4587, a large male skull, distorted and unsymmetrical ; and No. 4367, female ? from an ancient cemetery at Wailuka, Mani, in which the flattened occiput is very obvious.

The traces of purposed deformation of the head among the islanders of the Pacific have an additional interest in its relation to one possible source of South American population by oceanic migration, suggested by philological and other independent evidence. But for our present purpose, the peculiar value of those modified skulls lies in the disclosures of influences operating alike undesignedly, and with a well-defined purpose, in producing the very same cranial conformation among races occupying the British Islands in ages long anterior to earliest history ; and among the savage tribes of America and the simple islanders of the Pacific in the present day. They illustrate with even greater force than the rude implements of flint and stone found in early British graves, the exceedingly primitive condition of the British Islanders of prehistoric times.

On Variation in the Number of Fingers and Toes, and in the Number of Phalanges, in Man. By JOHN STRUTHERS, M.D., F.R.C.S., Lecturer on Anatomy in the Edinburgh School of Medicine. (Plate II.)

At the present time when the subject of variation is attracting so much attention, the following illustrations will, perhaps, be read with additional interest. I have arranged the cases of increase in the number of digits into

two groups, those which illustrate original variation, and those which illustrate the phenomena of hereditary transmission. The cases of variation in the number of the phalanges are given separately, as belonging to a different order of variation. In regard to those cases for which I am indebted to the kindness of various medical friends, whose names will appear, I may mention that they have been most carefully described to me in reply to a series of inquiries relating both to the anatomical condition and the hereditary history, and that what is stated may be relied on both for accuracy and for all possible completeness. A few remarks are added at the end on some of the points in variation and inheritance which the cases illustrate, and on the special point of the absence of a bone in the thumb and great toe, as compared with the other digits.

PART I.—VARIATION IN THE NUMBER OF DIGITS.

SECTION 1.—INCREASE IN THE NUMBER.

Group 1.—CASES WHICH COULD NOT BE TRACED TO HAVE HEREDITARY ORIGIN.

1. *Case of Six Digits in three members of a family, occurring Symmetrically.*

In this family of seven children, one of the daughters was born with six digits on each foot, and two of the sons with six digits on each foot and on each hand. I am indebted to the kindness of Dr John Alexander Smith for a full account of the case, and for affording me the opportunity of seeing the persons who are the subjects of the variety.

(a.) M—— O——, female, æt. 22, Edinburgh, was born with a

EXPLANATION OF PLATE II.

- Fig. 1. R. and L. Hands of J—— O——. Case 1. From a photograph.
 Fig. 2. Feet of J—— O——. Case 1. From a photograph.
 Fig. 3. Feet of C—— O——, younger brother to the last—Case 1. From a photograph.
 Fig. 4. Hand of G—— S——. Case 14. From a sketch.
 Fig. 5. Hand of J—— M——. Case 24. From a cast.
 Fig. 6. Hand of J—— J——. Case 26. From a photograph.

sixth toe on the outer side of each foot. That on the right foot, being loosely attached, was removed by the surgeon a fortnight after birth, and the cicatrix is visible. The sixth toe on the left foot is fully equal in size to the fifth, and is supported on the fifth metatarsal bone. The hands are normal.

(b.) The elder brother, J—— O——, æt. 19, has six fingers on each hand and six toes on each foot. The additional digits are placed on the outer side of the limb. Figs. 1 and 2 are taken from photographs of the hands and feet. Each sixth finger diverges considerably, reaches to a little beyond the joint between the proximal and middle phalanges of the fifth finger, and contains two phalanges, the proximal $1\frac{1}{4}$, the distal $\frac{3}{4}$ inch in length, the distal phalanx being somewhat longer on the left hand. The fifth and sixth fingers rest on one metacarpal bone, which broadens considerably in its distal third, where it is first grooved and then deeply notched, so that the bifurcated ends are as wide apart as the other knuckles. The left sixth finger looks shorter than the right, owing to the metacarpal head which supports it being farther back. The other fingers have the usual proportionate length. Each sixth finger moves with strength and quite as independently as the other fingers, without the others being held, and there is no tendency to move the fifth when he moves the sixth. The flexor and extensor tendons are, therefore, separate up to the muscles.

The sixth toe is well formed on each foot, lying parallel in the series. The fifth is of normal size, and the sixth rather larger than it, although, from commencing farther back, it does not project so much as the fifth. The fifth metatarsal broadens and then bifurcates to support the fifth and sixth toes, the bifurcation being greatest on the right side. Although it is not very easy to make this out, the sixth toe appears to have only two phalanges on each foot. The fifth and sixth toes are slightly webbed, but less so than the second and third, which are, as is common, webbed for $\frac{1}{4}$ to $\frac{1}{3}$ of an inch.

(c.) The younger brother, C—— O——, æt. 10, was born with twenty-four digits, like his brother. The toes, as seen in fig. 3, also from a photograph, exactly resemble those of the elder brother (fig. 2), making allowance for the latter having corns. I can make out three phalanges in all the lesser toes except the sixth, which appears to have but two. The fifth metatarsal bones bifurcate as in the brother. The sixth fingers projected outwards so inconveniently, that they were removed, together with their supporting head of the bifurcated fifth metacarpal bone, three years ago by Dr Smith, and a cicatrix and slight bony eminence remain. On examination of one of the removed fingers I find it to contain two phalanges, which appear to be entirely destitute of flexor tendons, the proximal phalanx alone having an extensor tendon.

History of the O—— Family.—The father and mother have the fingers and toes normal, and the variety was previously unknown in the family on either side. Both grandmothers were present at the birth of the daughter, the first child which presented the

variety, and both stated that they had never known or heard of it in their ancestors, neither having ever heard of such a thing before except in the case of the son of the giant in Gath, which they called to recollection in discussing the wonder. The first child of this family was a boy, without any digital peculiarity. The mother next had four miscarriages, between the 4th and 7th months, two boys and two girls, also it is stated with the hands and feet quite natural. The sixth child, the daughter M——, was the first to present the variety; she had six toes as above described. The family had lived in Forfarshire, and now went to Glasgow.

When again pregnant, the mother's thoughts must have been strongly turned in this direction, as she relates that she heard as it were a distinct voice from the wall of the room say that the child would have more than the last. This was about the second or third month, and made a deep impression on her mind. The child was the boy James O—— above described as presenting six fingers and six toes. Three daughters, successively, were the next children born, whose hands and feet were quite natural. Lastly came the boy Charles O——, above described as having been born with an additional digit both on the feet and hands.

Dr Smith has attended two of the daughters in their confinement; one has had three children all of whom have the fingers and toes normal; the other, the daughter who was born with six toes, has had one child, a male, who lived only a few days, in whom the toes and fingers were normal. M——, J——, and C—— O—— have two paternal uncles and two paternal aunts, and one maternal uncle and five maternal aunts, all of whom have families, and in none of them—uncles, aunts, or children—do the fingers or toes present any variety. The mother, Mrs O——, was a twin, and the twin sister has had three children.

The mother, Mrs O——, mentions that she used to work beside a girl who had a double thumb, but this was years before she was married. The father mentions that after the variety had occurred in his own family, he saw a man who was exhibited as a giant with six fingers and six toes. The O—— family mention the case of a railway guard (George B——), known to them after the variety had appeared among them, who had an additional finger on the ulnar side of his right hand, and an additional toe, also said to be on the right foot. He died a few months ago and leaves five or six children, none of whom have additional fingers or toes.

The following Seven Cases present an Additional Thumb on one Hand.

2. J — S——, æt. 25, Berwickshire, has an additional thumb on the right hand. The metacarpal bone bifurcates to support the two thumbs, which are of nearly equal length and thickness, that next the forefinger being slightly thicker and more powerful than the other. Each contains two phalanges, the proximal $1\frac{1}{2}$ inch, the distal 1 inch in length, being as long as those of the thumb of the left hand, except the distal phalanges, which are $\frac{1}{2}$ inch shorter.

In girth, each is only a little less than the left-hand thumb. The twin thumbs diverge from each other by their proximal phalanges, and converge by their distal phalanges, and are webbed half-way. In extension, the distal phalanges become parallel; in flexion, their points come together by their edges, and give a firm nip. Each can be flexed and extended separately when the other is held, but not otherwise. Flexion at the metacarpo-phalangeal joint is less extensive than usual. Motion at the carpo-metacarpal joint is free, and, in the movements of opposition, both of the thumbs move together across the hand. In writing, the pen lies between the approximated points of the two thumbs. He is right-handed as usual.

He states that variation in the number of the fingers or toes was previously unknown in the family.

3. E—— N——, æt. 13, Edinburgh (brought to me by my pupil Mr George Dickson), has an additional thumb on the left hand. The metacarpal bone is bifurcated for $\frac{1}{4}$ to $\frac{1}{2}$ inch, and forms two diverging heads for the two thumbs. The thumb next the forefinger is the larger of the two, and has nearly the usual length, but is not thicker than the last two divisions of the forefinger. The lesser thumb at first diverges to the radial side, and then curves forwards at the metacarpo-phalangeal joint, which is somewhat loose. It has only one phalanx, which is $\frac{1}{10}$ inch in length, the two phalanges of the greater thumb measuring together $1\frac{1}{2}$ inch. The two thumbs move together in opposing the fingers. The lesser thumb is flexed and extended in common with the other, and has considerable power in flexion.

Her mother states that variety in the number of fingers or toes was previously unknown in the family.

4. W—— G——, æt. 3 months, Edinburgh (kindly sent to me by Mr Edwards), has the thumb of the right hand double. The thumb next the forefinger is of good size, and has the usual number of bones. The lesser thumb consists of one phalanx, which is attached, firmly but quite moveably, to the inner side of the proximal phalanx of the greater thumb beyond its middle. It is about half the thickness of the greater thumb, is half the nail's length shorter, and they are webbed together as far as opposite the beginning of the two nails.

The mother states that the variety was previously unknown in the family.

5. I am indebted to Dr Edward Robertson of Otterburn for a note of the case of T—— H——, æt. about 6 months, Northumberland, who had an additional thumb on the right hand. It was rather loosely attached at the radial side of the metacarpo-phalangeal articulation of the greater thumb, which, again, was rather smaller than the thumb of the left hand. Dr Robertson lately removed the lesser thumb, and I find that it contains one phalanx only.

The father, mother, and maternal grandmother, all state that nothing of the kind was before known in the family.

6. My pupil, Mr Purves of Dryburgh, has procured for me a note, by his father, of the case of J—— W——, Berwickshire, a

man who has a small-sized additional thumb on the left hand. It contains one phalanx, which is attached rather loosely at the end of the metacarpal bone, as if by dense tissue and skin, without connection with the joint. He has no voluntary power over it, but it is more sensitive to pain than the greater thumb is. It is over an inch in length, and has a well-formed nail.

He states that "there is no hereditary tendency in his family to such formations."

7. For this (and for case 10. of this group) I am indebted to Dr Gibson of Campbeltown. — M'M——, æt. 14, Argyleshire, has a double thumb on the right hand. The metacarpal bone is much larger than its fellow in the left hand. The proximal phalanx is double, the two being wrapped in a common investment of skin, presenting a broad flattened appearance externally. The distal phalanges are separate, with a little space between them. They converge again at the points, giving the thumb a lobster's claw appearance. He is able to pick up small objects between the two points, and thinks such a thumb rather an acquisition, as in picking small things out of his vest pocket. He has the full use of the thumb in opposing the fingers.

He has three brothers and four sisters, none of whom have any digital variety. Neither have the father nor mother, nor do they know of any such variety in past generations of their families. The mother accounts for it from her seeing a man with a double thumb when she was pregnant, but says it was not the same kind of double thumb.

8. I am indebted to Dr Henderson of Fordoun for the particulars of the case of H—— K——, Kincardineshire, æt. 32, who has an additional thumb on the right hand. The thumb to the radial side, constituting the sixth digit, is considerably smaller and shorter than the other, and they are partially webbed. She can move the thumbs together so as to hold a pen between them.

A former child of the mother's, by a first marriage, had a sixth finger on the ulnar side of one hand, but lived only three weeks. No previous case is known in the family on either side. The mother has no story as to the cause.

Three Cases (two of them Brothers) presenting an Additional Little Finger on one Hand.

9. Dr Edward Robertson mentions to me also the case of John B——, æt. 5 years, Northumberland, from whom immediately after birth he removed a small supernumerary little finger from the left hand. A brother, who is now dead, had a similar supernumerary finger also on the outer side of the left hand.

The father and mother have never heard of any such variety in their ancestors, or in any relative of the family.

10. J—— G——, æt. 20 months, Argyleshire, has a sixth finger loosely attached to the outer side of the little finger of the left hand, near the middle of the proximal phalanx, and set at a right

angle to the little finger. It is $\frac{3}{4}$ of an inch in length, and has two phalanges. The little finger (fifth finger) is two inches in length. He is an only child. The father and mother have no such variety, and never heard of it occurring in the family before.

Three Cases presenting Six Toes on one Foot.

11. J—— S——, Liverpool, æt. 39, brother to one of my students, has six toes on the right foot. The external metatarsal bone is not broader at its middle than in the other foot, but becomes grooved and then bifurcated for a short distance at the head, supporting the fifth and sixth toes. I can make out three phalanges in the fifth toe, but the sixth seems to have only two. The long extensor tendon is felt and seen to bifurcate for the fifth and sixth toes. The five lesser toes form a regular series retiring outwards, with nothing to attract notice except the number. It was some months, he mentions, until his mother made the discovery that he had a toe more on one foot than on the other. There is no trace of any attempt to throw out a sixth digit on the other foot, or on the hands.

He states that variety of the toes or fingers was previously unknown in the family, and he can trace his ancestors for several generations back. He is one of six brothers, none of whom are married but himself, and he has no family, although there have been several miscarriages. He has five sisters, four of whom are married and have families, but none present any digital variety. He is a very tall man, standing six feet four inches in his shoes. The brothers are rather tall, but under six feet. The mother and sisters are not tall. The father was under six feet.

12. I am indebted to Dr Finlay of Trinity, Edinburgh, for the opportunity of examining this case, and also the two next:—

J—— L——, æt. 40, Newhaven, has six toes on the left foot. The fifth metatarsal bone is broader than the corresponding bone in the right foot, and supports the fifth and sixth toes. The fifth toe is narrower than the sixth, and has three phalanges, while the sixth seems to have only two phalanges. The extensor tendons of the fifth and sixth toes are seen to come forward together. The fourth and fifth toes are partially webbed.

No instance of digital variety is known to have occurred among his ancestors on the father's side, who have lived in Newhaven from time immemorial. The grandmother came from Edinburgh, and said that it was equally unknown among her ancestors. J—— L—— has a brother and four sisters; he himself has a family of four boys and one girl; his brother has one son; and three of his four sisters are married, and have families of sons and daughters; but no member or relative of the family has any digital variety except himself.

13. R—— L——, æt. 15, Newhaven, has six toes on the left foot. The fifth and sixth toes are supported on one metatarsal bone. The fifth is a small toe, the sixth thicker than the little toe

of the other foot. The fifth and sixth toes have each only two phalanges; the proximal phalanges are close together, but can be made to move past each other. Digital variety is unknown in the family on either side. R—— L—— is one of nine children, three boys and six girls. The father's family have, as usual with the Newhaven fishermen, always been in Newhaven. The grandmother came from the Highlands, and never knew of such a thing on her side of the family. Both the father and mother have brothers and sisters in Newhaven, all with families of sons and daughters. The mother states that her father's left little toe grew very awkwardly across the others, not in consequence of the pressure of the shoe, but naturally.

A friend showed me the other day a peculiar curve of his little finger, which two of his brothers also have. His father's mother had exactly the same peculiarity; also some of the children of a paternal uncle.

14. *Case in which one Hand presents Seven or Eight Digits, forming an approach to the condition of Double Hand.*

G—— S——, æt. 5, has seven digits on the left hand, and the one corresponding to the thumb double at its distal segment, constituting so far an eighth digit. In every other respect the boy is well formed. The appearance presented by the hand is seen in fig. 4. There are seven distinct metacarpal bones. The four fingers on the outer side present the usual form and proportionate length, each with its three phalanges. The fifth has the position and opposing action of the thumb. Besides the metacarpal bone, it has two segments, the distal of which contains two phalanges placed side by side, while the proximal phalanx is single. The twin distal phalanges can be made to move a little past each other, and the one to the inner or radial side ends partly by a prominent non-articular angle, as if its proximal phalanx were wanting. They are closely enveloped in a common integument, and their nails join at their contiguous edges. He moves the thumb independently and freely, so that all its tendons must be separate from those of the digits on either side. The sixth and seventh digits are like the ring and little fingers of a right hand, except that the little finger is proportionately small. Each has three phalanges, and they are webbed most of the way between the proximal phalanges. Their metacarpal bones are quite separate and moveable, and, as they pass up, have a direction forwards to the palmar aspect of the carpus. These two fingers are associated together in their movements, and can be moved independently of the rest of the hand, but there is a tendency to flex the other fingers at the same time. In general grasping, the thumb and sixth and seventh digits oppose the other four and clasp down upon them. The hand is flat where the ball of the thumb should be.*

* A somewhat similar case, in which the duplicity of the hand was more complete, with a rudimentary condition of the thumbs, by Mr J. Jardine

A grandfather and grandmother are still alive. The father has three brothers and three sisters, besides two sisters who died. Two of the brothers and the three sisters are married, all of whom have families of sons and daughters, except one of the brothers whose children are all daughters, and the father himself has three daughters and another boy besides G——. But no other case of such, or of any, digital variety has been or is known in the family, either on the father's or on the mother's side.

Group 2.—CASES OF INCREASE IN THE NUMBER OF DIGITS, WITH HEREDITARY ORIGIN.

15. Case in which the Variety has been transmitted through at least Four Generations.

I am indebted to Dr Hamilton of Falkirk for the following case (and for case 16), and have to thank him for the great trouble and interest he has taken in ascertaining the genealogy of the family.

The great-great-grandmother, Esther P—— (who married A—— L——), had a sixth little finger on one hand. Of their eighteen children (twelve daughters and six sons), only one (Charles) is known to have had digital variety. We have the history of the descendants of three of the sons, Andrew, Charles, and James.

(1.) Andrew L—— had two sons, Thomas and Andrew; and Thomas had two sons; all without digital variety. Here we have three successive generations without the variety possessed by the great-grandmother showing itself.

(2.) James L——, who was normal, had two sons and seven daughters, also normal. One of the daughters became Mrs J—— (one of the informants), and had three daughters and five sons, all normal except one of the sons James J——, now æt. 17, who had six fingers on each hand. The additional fingers in this boy's case were loosely attached at the metacarpo-phalangeal joint of the little finger, and were removed by Dr Hamilton a few days after birth.

In this branch of the descendants of Esther, we see it passing over two generations and reappearing in one member of the third generation, and now on both hands.

(3.) Charles L——, the only child of Esther who had digital variety, had six fingers on each hand. He had three sons, James, Thomas, and John, all of whom were born with six fingers on each hand, while John has also a sixth toe on one foot. He had also five other sons and four daughters, all of whom were normal.

(a) Of the normal children of this, the third generation, the five sons have had twelve sons and twelve daughters, and the four

Murray of Brighton, was lately communicated to the Royal Medico-Chirurgical Society of London. Noticed in "The Lancet," Dec. 20, 1862. I am aware of a case of a child with complete double foot, at least at the digital and metacarpal part, but have as yet seen only a sketch of it.

daughters have had four sons and four daughters, being the fourth generation, all of whom were normal. A fifth generation in this sub-group consists as yet of only two boys and two girls, who are also normal.

In this sub-branch, we see the variety of the first generation present in the second, passing over the third and fourth, and also the fifth as far as it has yet gone.

(b) James, had three sons and two daughters who are normal.

(c) Thomas, had four sons and five daughters who are normal; and has two grandsons, also normal.

In this sub-branch of the descent, we see the variety of the first generation, showing itself in the second and third, and passing over the fourth, and (as far as it as yet exists) the fifth generation.

(d) John L—— (one of the informants) had six fingers, the additional finger being attached on the outer side, as in the case of his brothers James and Thomas. All of them had the additional digits removed. John has also a sixth toe on one foot, situated on the outer side. The fifth and sixth toes have a common proximal phalanx, and a common integument invests the middle and distal phalanges, each having a separate nail.

John L—— has a son who is normal, and a daughter, Jane, who was born with six fingers on each hand and six toes on each foot. The sixth fingers were removed. The sixth toes are not wrapped with the fifth, as in her father's case, but are distinct from them. The son has a son and daughter, who, like himself, are normal.

In this, the most interesting sub-branch of the descent, we see digital increase, which appeared in the first generation on one limb, appearing in the second on two limbs, the hands; in the third on three limbs, the hands and one foot; in the fourth on all the four limbs. There is as yet no fifth generation in uninterrupted transmission of the variety. The variety does not yet occur in any member of the fifth generation of Esther's descendants, which consists, as yet, only of three boys and one girl, whose parents were normal, and of two boys and two girls whose grand-parents were normal. It is not known whether, in the case of the great-great-grandmother, Esther P——, the variety was original or inherited.

16. *Case of Additional Thumb, with distant Hereditary Origin.*

—— B—— æt. 3, Linlithgowshire, was born with an additional thumb on the left hand, which Dr Hamilton removed when she was a few months old. The upper end of the proximal phalanx was left, for security to the metacarpo-phalangeal joint, and has since grown to some extent. It was not much smaller than the thumb which was left. The only other child, also a daughter, is normal.

The mother's maternal uncle (W——) had a thumb of the same kind, which Dr Hamilton has seen. His five sons and five daughters, however, were normal. The mother of the girl B—— is one of a family of four brothers and five sisters, all of whom are normal, and

their children, twenty-four sons and twenty-seven daughters, were likewise all normal, except one of Mrs B——'s daughters, being the case under description.

The occurrence of it in the maternal grand-uncle, indicates the variety to have existed in some generation previous to his. The case shows it to have passed over at least two generations, the grandmother and the mother, and to have reappeared in the third generation in the case of the girl B——.

For this and the five following cases 17, 17 (a), 18, 18 (a), 19, 19 (a), I am indebted to Dr Gibson of Campbeltown, who has most kindly taken much interest and trouble in obtaining and sending me the information.

17. Case of Additional Digit on one Hand, with Three Phalanges and a Metacarpal Bone ; and Additional Digit on each Foot. Direct Hereditary Origin.

W—— S——, æt. 73, Argyleshire, has, on his left hand, a sixth finger, placed midway between the thumb and fore-finger. It has three phalanges and a metacarpal bone, all clearly felt. It hangs pendulous, not having the power of extension. Its length is $3\frac{1}{2}$ inches, that of the thumb being $2\frac{1}{2}$, that of the fore-finger 4 inches. The thumb and fore-finger are each 3 inches in circumference, the intermediate digit $2\frac{3}{4}$.

He states that he has six toes on each foot, and that the additional toe is placed and formed in the very same way as in the hand. His children, four in number, are without digital variety, but it is hereditary, as fully given with the next case, that of a sister.

17 (a). Case of Two Thumbs, one of them with Three Phalanges on each Hand ; and Two Great Toes on each Foot, with an Additional Metatarsal Bone on one Foot. Direct Hereditary Origin.

A—— S——, Argyleshire, has six digits on each hand and on each foot. The additional digit is on the inner side. One of the thumbs presents three phalanges, on each hand, and one of the additional great toes has a separate metatarsal bone.

The two thumbs are supported on one unbifurcated metacarpal bone. The thumb next the fore-finger is clearly felt to have three phalanges, while the lesser thumb has two phalanges. It is the same on both hands. The greater thumb is $2\frac{3}{4}$ inches in length on the left hand, and $2\frac{1}{2}$ on the right ; the lesser thumb is 2 inches in length on both hands. The circumference of the greater thumbs on the left and right sides, respectively, is $2\frac{1}{2}$ and $2\frac{1}{4}$, that of the lesser thumbs being 2 inches. The two thumbs are webbed at their base. In each hand, it is the thumb next the fore-finger which is used.

In the *left foot* there are two great toes growing from one metatarsal bone, each having two phalanges, which are distinctly felt. The inner toe is the greatest, is $2\frac{1}{2}$ inches in length and $3\frac{1}{2}$ in circumference; the outer is 2 inches in length and 2 inches in circumference.

On the *right foot* there are six toes very regularly set, and six metatarsal bones. The great inner toe has two phalanges, is 2 inches in length, and $3\frac{1}{2}$ in circumference; the second is $1\frac{3}{4}$ in length, and $2\frac{3}{4}$ in circumference, and has two phalanges. The outer of the two great toes—that next the other toes—is therefore the lesser on both feet.

The variety is in the family. It came into the family through the paternal grandmother, who was a relative of the —— family, in which digital variation exists. This grandmother herself is not stated to have had the variety, but the father of A—— S—— had six toes on each foot and “very long thumbs.” Of his seven children, a daughter and three sons have no digital variety; the other daughter has, as above described, six digits on each hand and foot; a son has the great toes double; and the remaining son, whose case is last described, has six digits on each foot and on one hand. This son has four children, who are all normal. Of the other sons, two, who are normal, are married and have fifteen children, all of whom are likewise normal.

18. *Case of Double Distal Phalanx of Thumb, with distant Hereditary Origin.*

J—— H——, æt. 70, Argyleshire, has the thumb on the right hand double at the distal phalanx, while the metacarpal bone, and the proximal phalanx, are single. The distal segment is at first much flattened, and then bifurcated for about half an inch; each has a separate phalanx and a nail. The distal divided segment remains constantly extended.

Neither of his six brothers, or eight sisters, or father or mother, had any digital variety. His maternal grandmother, herself normal, was a member of the family already alluded to, among whom such variety exists; and the next case is that of a sister's grand-daughter.

18 (a). *Case of Additional Thumb on each Hand, with Additional Metacarpal Bones, and Double Great Toe on one Foot. Distant Hereditary Origin, connected with the preceding case.*

J—— D——, æt. 4, Argyleshire, has two thumbs of equal size on each hand, and a double great toe on the left foot. The two thumbs on each hand have each two phalanges, and also each a metacarpal bone. The two thumbs of each hand possess flexion and extension and other motions perfect, and are equally useful.

The metatarsal bone of the left great toe appears to be grooved

but not bifurcated. Each of the great toes which it supports has two phalanges. They are wrapped in a common integument, except near the point, where they separate. Each has a nail. The phalanges of the outer lie partly upon those of the inner great toe. She has a brother and two sisters, but no member of the family, later than the brother of her maternal grandmother (case of J—— H——, last related), has any digital variety. She is, through the same channel, a distant cousin of the family, already alluded to, among whom digital variety exists.

19. *Case of Additional Thumb on one Hand, with distant Hereditary Origin.*

J—— F——, æt. 8, Argyleshire, has an additional thumb on the left hand. The distal end of the metacarpal bone is bifurcated. The lesser thumb is situated on the inner side, and has two phalanges. It is $1\frac{1}{2}$ inch in length, the larger thumb being 2 inches. The distal phalanx of the lesser thumb remains in the flexed position, and cannot be extended voluntarily. The thumb of the right hand is longer than usual, and is somewhat finger-like.

He has one brother and two sisters, neither of whom have digital variety, nor have the father or mother. The father's great-grandfather is said to have had some digital variety. The thumb on the right hand is longer than usual, and somewhat finger-like.

19 (a). *Case of Additional Thumb on one Hand, with Additional Metacarpal Bone. Distant Hereditary Origin.*

S—— M——, æt. 7, Argyleshire, has an additional thumb on the right hand. It has two phalanges and a metacarpal bone, which articulates with the inner side of the metacarpal bone of the greater thumb, near the carpal extremity. The larger thumb is 2 inches in length, the lesser $1\frac{1}{2}$. It begins to leave the greater thumb opposite about the middle of the metacarpal bone of the latter, and its point reaches to the last joint of the greater thumb, along the side of which it lies. All the bones are clearly felt.

She has four brothers and five sisters, who, as well as the father and mother, have no digital variety. A first cousin, daughter of a maternal uncle, had a double thumb.

20. *Case of Six Fingers and Toes, with Interrupted Hereditary Origin.*

I am indebted to Mr J. Jardine Murray, F.R.C.S. Edinburgh, of Brighton, for a note of the case of C—— G——, æt. 12 months, who was born with six fingers on each hand, the additional finger being on the ulnar side, and six toes on the right foot. The sixth toe is on the outer side of the foot, and lies more upon the dorsum

than to the outer side of the fifth toe. Mr Murray removed the supernumerary fingers in July 1862.

A brother has the same variety. The grandmother, on the father's side, had the same variety; also a sister of the father's.

SECTION 3.—DIMINUTION IN THE NUMBER OF THE DIGITS.

21. *Dissection of Three Limbs of a Child, presenting Diminution in the Number of the Digits.*

The child was born with the right hand presenting only two fingers, webbed together; the right foot presenting but three toes; and the left foot with the fourth and fifth toes united at their base. I was indebted to the kindness of Dr Keiller for obtaining the limbs. I have no history to the case, but have thought it worthy of notice from the opportunity of ascertaining by dissection how far the variation affected the deeper parts—the bones, muscles, and nerves.

(1.) DISSECTION OF HAND.—Externally there are two digits, one on the radial side considerably thicker than the other. It will be convenient to speak of the first as the pollex, and of the other as the little finger. They are webbed to the end, presenting a notch at the end on the palmar aspect. The nails are distinct, but close together. The palm is the same breadth as the forearm, and gradually tapers into the fingers. Both palm and fingers have the usual length in proportion to the forearm.

BONES.—Each digit has only two phalanges, the proximal about twice the length of the distal. There are two metacarpal bones. The four bones of the proximal carpal row are present, the second, or semilunar, small. The second row of carpals is represented by two bones, which are coalesced with, or prolonged from, the first row. The piece supporting the ulnar metacarpal, corresponds in position to the unciform, and is fused with the cuneiform. The piece supporting the radial metacarpal is fused behind with the scaphoid, and may represent the os magnum, trapezoid, or trapezium, or all three fused together. The bones and joints of the forearm are fully developed.

MUSCLES.—All the muscles of the forearm are present except one. The pronators and supinators are unusually large, as is also the Flexor Carpi Ulnaris. The *Flexor Sublimis Digitorum* is small, wants its radial origin, and ends in two tendons; one joins the tendon of the deep flexor, which goes to the little finger, the other ends in the annular ligament. The *Flexor Profundus Digitorum* is full sized, and ends in two tendons; one, the larger, ends in the annular ligament, the other forms a strong flexor tendon, going on to the distal phalanx of the little finger. The latter is joined at the wrist by the tendon of the superficial flexor, which is here pierced by the deep tendon, after which the two are incorporated.

The absence of a *tendo perforatus* proceeding separately to the finger corresponds to the fact of the absence of one of the phalanges. The *Flexor Longus Pollicis* is large, arising also from the edge of the ulna. It proceeds entirely to the distal phalanx of the pollex. It is not joined by any slip, except that, above, the fleshy slip which usually descends to the muscle from the condyloid origin of the *flexor sublimis* is unusually large.

The short muscles of the little finger are all present with the usual attachments. So also the short muscles of the thumb, with some modification. The *Abductor* is large. The *Adductor* arises from the annular ligament. The *Opponens* is small, much smaller than the *opponens* (*flexor ossis meta-carpi*) *minimi digiti*. The *Flexor Brevis Pollicis*, undersized, arises from the two sides of the metacarpal bone; the ulnar head appearing like a second *interosseous*. There is one *Interosseous* muscle for the little finger, along its radial side.

Extensor Muscles.—The *Extensor Carpi Radialis Longior* sends a small tendon to the base of the metacarpal bone of the pollex, and a large tendon to between the bases of both metacarpals, chiefly to the ulnar. The *Extensor Carpi Radialis Brevior*, also large, goes to the carpus just above the ulnar metacarpal. The *Extensor Carpi Ulnaris* is entirely wanting. The *Extensor Communis Digitorum* gives a tendon to each finger, that to the pollex only a little the largest. The *Extensor Minimi Digiti* is quite distinct from the latter as a muscle. Its only tendon goes to the little finger, joining with the tendon to that finger from the common extensor, the latter being the larger. Two muscles form the deep layer. One has the fleshy attachments of the *Extensor Ossis Metacarpi Pollicis*, but its tendon goes to the first phalanx, and is therefore the *Extensor Primi Internodii*. The other muscle has the fleshy attachments of the long extensor of the thumb, and the extensor of the fore-finger. Besides two tendinous slips to the back of the carpus, it ends in two tendons which join the tendons of the long common extensor. One of them, therefore, represents the *Extensor Secundi Internodii Pollicis*; the other the *Extensor Indicis*, going to the only remaining finger.

NERVES.—The *Ulnar* supplies the ulnar side of the little finger, and unites with the median for the supply of the radial side of the same finger. The *Median* supplies both sides of the pollex, and is also the principal nerve for the ulnar side of the little finger. The interdigital space receives for its supply, as above described, a series of nerves, three from the median and two from the ulnar, as if the nerves of the wanting fingers had been crowded into the cleft.

(2.) **DISSECTION OF RIGHT FOOT**.—This foot presents three toes, the internal having the usual characters of the great toe.

BONES.—Each of the lesser toes has the three phalanges—the great toe the usual two. The *metatarsal* bones are three in number, the internal having its usual great size. The second *tarsal* row presents a bone for the support of each metatarsal—two cuneiform bones and the cuboid—but the latter is fused with the os calcis.

The part corresponding to the cuboid has a separate bony nucleus, smaller than the nucleus of the os calcis. Of the first row, the astragalus is fused with the os calcis, and the scaphoid is wanting or fused with the astragalus.

MUSCLES.—The *Flexor Brevis Digitorum* sends tendons to the two lesser toes, that to the external being much the largest. The *Flexor Longus Digitorum* and *Flexor Longus Pollicis* are separate muscles in the leg, but at the ankle form a common tendon, which at the middle of the foot, after receiving a large accessorius, divides into two, one for the great toe, the other for the second toe, which perforates the tendon of the short flexor. There is one *Lumbricalis*, arising from both sides of the long tendon to the second toe, and going to the tibial side of the same toe. Two muscular bundles arise from the abductor minimi digiti, besides the usual tendon of that muscle, and proceed one to the fibular side of the second toe, the other to the tibial side of the outer toe. They are like large lumbricales, or additional short flexors. The *Flexor Brevis Minimi Digiti* is wanting. There are two plantar *Interossei*, one for the tibial side of each of the two lesser toes; and one dorsal, in the outer space, for the middle toe.

Extensors.—The *Extensor Brevis Digitorum*, gives five distinct digital tendons, three to the middle toe, one of which is larger than the tendon to the outer or to the great toe. All of the five come, as usual with the tendons of this muscle, from separate portions of the muscle. A sixth portion and tendon passes to the external metatarsal bone, and here represents the peroneus tertius, which is wanting in its usual situation. The *Extensor Longus Digitorum* is small, and gives at the ankle a tendon to join the extensor longus pollicis, the rest of the tendon ending on the os calcis. It is just possible that an intra-uterine fracture of the tibia which had taken place, with angular union, may account for the atrophy of this muscle, but the other muscles of the leg are well formed. The *Extensor Longus Pollicis* is large and separate throughout, except that it receives a tendon from the extensor longus digitorum.

The muscles not alluded to in these notes present their usual arrangement.

NERVES.—The distribution of the plantar digital nerves is somewhat remarkable. The *external plantar* sends a nerve to the fibular side of the outer toe, and a second to both sides of the outer interdigital cleft. The *internal plantar*, which has the usual preponderance in size, sends, first, a nerve for the tibial side of the great toe; second, a branch to the internal cleft which gives off first one and then a second set of subdivisions to the sides of the cleft, the double nerve on each side keeping a plantar course; third, a branch to join with the external plantar in supplying both sides of the outer cleft. Also there is a twig from the deep or muscular division of the external plantar, through below the flexor brevis digitorum muscle, to join one of the branches of the internal plantar to the fibular side of the great toe. A similarly derived and similarly

placed connecting twig passed from the ulnar nerve to the median in the right hand.

The distribution of the internal plantar nerve, taken alone, would indicate that the wanting toes are the two outer; while the distribution of the external plantar, taken alone, would indicate that the second and third are the wanting toes; but the double apparatus of nerves to each cleft, and their source, is exactly explained by supposing the second and fourth to be the wanting toes.

(3.) DISSECTION OF LEFT FOOT.—The fourth and fifth toes are united at their bases. The foot is in the condition of talipes varus.

BONES.—The bases of the proximal phalanges of the fourth and fifth toes are united in a single piece, and in front of this they are held together by a strong transverse ligament, with an anterior concave edge. Each of the lesser toes has three phalanges, except the fifth, in which the distinction between the second and third phalanges is not evident, but the softness and smallness of the parts render it difficult to pronounce as to this. It has, however, a tendon from the flexor brevis digitorum muscle. The fifth *metatarsal* bone is wanting. The fourth is double sized, broader but not bulkier than that of the hallux, but it presents no trace of duplicity externally, and a section shows one large medullary canal. The *tarsal* bones present no variety, except that the cuboid is narrower than usual, having only one metatarsal bone to support, and that the astragalus is fused with the os calcis.

MUSCLES.—The fourth and fifth toes receive no tendon from the *Extensor Brevis Digitorum*, and but one tendon from the *Extensor Longus Digitorum*, which divides at the metatarso-phalangeal joint into a tendon for each of the partially united toes. The external tendon of the *Flexor Brevis Digitorum* divides in the same manner at the head of the metatarsal bone to supply these two toes. So does the external tendon of the *Flexor Longus Digitorum*, after crossing the metatarso-phalangeal joint.

The most external of three *Lumbricales* is double-sized and goes to the tibial side of the fourth toe. The first lumbricalis, besides going to the tibial side of the second toe, sends a slip to the fibular side of the great toe. A muscle arises partly with, partly behind, the adductor pollicis, and goes to the neighbouring sides of the second and third toes. Of the two plantar *Interossei*, the external is very large and goes to the fourth toe. The *Flexor Longus Digitorum* and *Flexor Longus Pollicis* form a common muscle and tendon. The muscle splits naturally enough into two, but the outer portion comes mainly from the tibia and partly from the upper part of the fibula, the usual place of origin of the flexor longus pollicis from the fibula being unoccupied. The tendons of these two portions form one indivisible tendon above the ankle, which after receiving the accessorius, divides into four tendons, the internal for the hallux being the greatest, the external, as already noticed, for the two partially united outer toes.*

* It is an error to regard the so-called “Flexor Longus Pollicis” as a flexor of the great toe only, or to consider the presence of a tendon from it to

PART II.—VARIATION IN THE NUMBER OF PHALANGES.

SECTION 1.—DIMINUTION IN THE NUMBER.

22. *Case in which all the Fingers and Toes want a Phalanx, in several Members of a Family.*

I am indebted to Dr Oswald H. Bell of St Andrews for the description and history of this case, and for affording me an opportunity of seeing the boy.

David M —, æt. 18, St Andrews, wants a phalanx in each of his fingers and toes, and has a brother and sister similarly formed. The two hands are precisely similar. The thumb consists of a short metacarpal bone ($\frac{5}{8}$ inch in length) and of one phalanx, $1\frac{1}{8}$ inch in length, the joint between them being loose, as if composed of some soft intermediate tissue. The fore finger is so much longer than the others as to suggest the appearance of a hand in the act of pointing. This is due to the greater length of its metacarpal bone, which is 3 inches in length, while the next two metacarpals are under half that length. The metacarpal of the little finger is just $1\frac{1}{2}$ inch in length, but, from its obliquity, does not project so far as the fourth. The proximal phalanx of the fingers measures, in the index $1\frac{3}{8}$, in the middle $1\frac{3}{8}$, in the ring 1, in the little finger $1\frac{1}{8}$; the distal phalanx, in the index and middle, $\frac{7}{8}$, in the ring and little fingers $\frac{5}{8}$ inch. On the left side, the distal phalanx of the index finger is proportionately shorter. Except in the case of the fore finger, the five digits present their usual relative projection. The metacarpo-phalangeal joints, especially of the index and middle fingers, are considerably sunk behind the web, and are loose, while the joint between the two phalanges does not bend down with the usual degree of angularity.

He can easily seize and retain minute articles as a needle or pin, between the thumb and index finger, and can write with comparative ease. Being a groom, he can drive tolerably well, though he is apt to let the reins slip, being unable in the usual way to form the digital hook which the third phalanx naturally completes.

The feet are well formed as far forward as the distal ends of the metatarsal bones. The toes are short, pulpy, and very loosely articulated. The lesser toes have two phalanges each, and are much turned up at the interphalangeal joint; the great toe has its usual proportionate greatness, but, like the thumb, has only one phalanx. The pads below the anterior end of the metatarsal bones, behind both the great and lesser toes, are more developed than usual. No

the second toe as an occasional occurrence only. The tendinous slip commonly described as passing between the Flexor Longus Pollicis and the Flexor Longus Digitorum, in the sole of the foot, is nothing less than a tendon from the former to at least the second toe, of good size when the proportionate size of the two toes is considered. It is, normally, the principal flexor tendon of the second toe, and the first lumbricalis muscle is attached chiefly to it. (See communication by the author to the Edin. Medico-Chirurgical Society, "Edin. Medical Journal," July 1863.)

one would suspect from his gait any deficiency in the feet. He is 5 feet 2 inches in height, healthy and active.

Family history.—He is one of a family numbering ten in all, who were born in the following order. First, a son, and then successively three daughters, all normal. Fifth, a son, the first member of the family who presented the digital variety. Sixth and seventh twin girls, normal. Eighth and ninth, twin boys, one normal, the other whose case is above described. Tenth, a girl, with fingers and toes as in this boy, and, in addition, the feet turned in. Neither Dr Bell nor I have seen the brother and sister who have the variety, but the boy states that their fingers and toes are the same as his, the hands so like that when the arms are covered and the hands presented promiscuously, the mother cannot say to which brother they belong. The brother is a clerk and is said to write an excellent "hand." We have no information as to the ancestors, but neither of the parents, uncles, aunts, or cousins, had or have any deformity.

23. *Case in which four Fingers of one Hand possess but one Phalanx each, the Thumb having two Phalanges.*

Dr Henderson of Fordoun sends me a note and sketch also of the case of A—— W——, æt. 3½ years. The four outer digits of the left hand are short nipple-like processes containing one phalanx each, so loosely attached to the metacarpals that they can be easily twisted round. Each has its little nail. The thumb contains two phalanges, is as large as that of the other hand, projects a long way beyond the fingers, and she makes great use of it.

Her father has an aunt with two thumbs on the left hand, similar to the case of H—— K—— (No. 8).

24. *Case in which the Fingers are formed so as to give the Hand a resemblance to a Foot.*

I am indebted to Dr Grierson of Thornhill for the description, and for sketches of the hand, of this case, a cast of which I had previously seen, obtained through Dr A. Mitchell and Dr A. Simpson.

J—— M——, æt. 16, Dumfriesshire. The hand may be described, generally, as having a remarkable general resemblance to a foot, in the size and straight direction of the thumb, and the little development and outward lessening of the fingers. The sketch (fig. 5) will give a correct idea of the form of the hand. The thumb is the longest and thickest of the digits, and lies parallel to the fingers. It can be abducted, and only half crossed over the palm. It has two phalanges, besides the metacarpal bone. The distal end of the latter extends a little way beyond the separation between the thumb and next finger. The thumb alone has a nail. The next two fingers project for about an inch, the index more, the middle less. The ring and little fingers appear only as fleshy finger points. There is a bone projecting some way into the index and also into the

middle finger, either a phalanx or a prolongation of the metacarpal bone. The fourth and fifth fingers have no phalanges. The fingers have no voluntary motion. Viewed on the palm, the "ball" of the thumb is flat and narrow, but the eminence formed by the muscles of the little finger is prominent.

The other hand and the feet are normal. She is the third child in a family consisting of six daughters and three sons, all the rest of whom, as well as the father and mother, are normal. No such formation is known to have been presented by any ancestor. The mother's story is that in her third month of pregnancy she had a vivid dream that she saw a man killed and his fingers cut off, at her own door; that she told this at the time to her husband and neighbours, and could not for long get rid of the idea of the cut-off fingers.

25. *Case of Five Rudimentary Digits on one Hand.*

Mr James R. Crease of Gateshead, sends me the particulars and a sketch of the case of a female child, M—— J—— T——, ten days old, whose right hand presents a very rudimentary condition. The four fingers are present as mere rudiments, without nails; the thumb is about $\frac{1}{4}$ inch in length and has a nail. After the radius and ulna there are no bones to be felt in the hand, except one supporting the thumb. The rest of the limb is well formed.

Digital variety was previously unknown in the family history. There are three other children, boys, all well formed. An aunt by the father's side, had all the fingers, but not the thumb, of the right hand amputated, but the mother had not seen her for many years. When the mother was three months pregnant, her attention was attracted by a woman singing in the street who had a deformed right hand. For a time she always thought she saw this woman, but had no idea that anything would be wrong with the child.

SECTION 2.—INCREASE IN THE NUMBER OF PHALANGES.

26. *Case of Additional Phalanx in the Thumb, on both Hands. Probably of Hereditary Origin.*

J—— J—— æt. 21, Roxburghshire, now in Edinburgh, has the thumb on both hands of unusual length and form, as represented in Fig. 6, which is taken from a photograph. In examining the thumbs I was surprised to find an additional joint, giving three phalanges besides the metacarpal bone, the additional bone being placed in the position of a middle phalanx. A case so unusual deserves careful examination.

The metacarpal bone is $2\frac{1}{4}$ inches in length and appears to be quite normal. The first phalanx is $1\frac{3}{4}$ inch in length, and is, therefore, longer than usual. The *additional bone*, occupying the position of a middle phalanx, is broader on the inner, or radial, side than on the side next the index finger, having a triangular or wedge-shaped figure, which gives the distal phalanx an inclination towards the index. It measures along the radial side $\frac{5}{8}$ inch, along the ulnar

side $\frac{1}{4}$ inch, and $\frac{1}{2}$ an inch along the middle. The position of the base of this wedge-shaped additional bone is shown in the sketch by the double protuberance on the radial side. Between these a depression may be felt corresponding to the short shaft between the two articular ends. The distal phalanx is an inch in length. The measurements were made exactly from the joints, avoiding the error of including the knuckle twice.

When the thumb is straightened, its point passes a sixth of an inch beyond the joint between the proximal and middle phalanges of the index finger. The thumb of the right hand scarcely advances so far as that joint. The unusual length of the thumbs in this case is gained by the proportionately greater length of the proximal phalanx and by the presence of the additional bone, while the distal phalanx is a little shorter than usual. At the joint on the proximal side of the additional phalanx there is the usual extent of flexion and extension. Between it and the distal phalanx passive motion is free and readily felt in both thumbs, although it cannot be carried so far as to cause an angle or additional knuckle. Some motion in the lateral direction also can be made at this joint. The utility of the thumb is not impaired. The fingers are longer than usual (their lengths, from the metacarpo-phalangeal articulation, are, fore-finger $3\frac{7}{8}$, middle $4\frac{3}{8}$, ring $4\frac{3}{8}$, little $3\frac{1}{2}$, inches. The whole hand is 8 inches in length), present the usual proportionate length, and have three phalanges each. The great toes present the usual length, size, and number of phalanges. He is of full average stature, his height being 5 feet $9\frac{1}{2}$ inches.

A maternal aunt had the same kind of thumb on the right hand, being the only instance of the occurrence of the peculiarity in any relative of the family. This aunt has a son and three daughters. The mother had other three sisters and two brothers, all of whom, except one of the sons, have families of sons and daughters. The mother never heard that any of her ancestors had it.

REMARKS.

As some of the cases in the hereditary group show the tendency to have passed over at least two generations and then to have reappeared, it is possible that some of the cases recorded as original, may be cases of distant inheritance. But it must have had a beginning in these too. Careful inquiry was made in all the cases, and the previous occurrence of such a thing in the family is pretty sure to be brought up when a child is born with it. The cases one would feel most inclined to doubt on this score, are those in which it appeared in more than one child of the family, as in cases 1, 8, and 9.* In such cases we may suppose the

* I am indebted to Dr Strachan, of Dollar, for a case (which has arrived too late for detailed insertion at present) closely resembling Case 1. In a

cause which determined the occurrence in one child might equally determine it in another, or it might be held that the first case having occurred spontaneously, the circumstance had operated by an impression on the mind of the mother.

In all the cases of original variation, except in Case 1, and in one of the children in Dr Strachan's case, it appeared on one limb only.

This was not to any marked extent on one side of the body more frequently than on the other. The greater acquired strength of the right hand and foot might be supposed to operate on the offspring, but in the above cases it so happens that it appeared rather more frequently on the left side. Throughout the animal kingdom, when one side is more developed than the other, the right side is not selected more frequently than the left.*

The variation begins more frequently on the hand than on the foot. In the non-hereditary group of cases in which it affected either a hand or a foot only, it appeared on the hand in eleven of the cases, on the foot in four cases. The hereditary cases, by multiplying the fact, show a still higher proportion affecting the hand than the foot; and in the cases in which it occurs on three of the limbs, it is on a foot more often than on a hand that the sixth digit is wanting. None of the cases show hereditary transmission of the peculiarity on the feet alone, while the cases of hereditary transmission on the hands only are more numerous than those showing it on the hands and feet. This greater frequency of its appearance on the hand may be connected with the zoological fact that in those mammals in which the digits differ in number on the two feet, the greater number is on the fore foot; or, more generally, with the fact that greater separate use is made of the digits on the hand than on the foot.

The additional digit appears nearly equally on the outer or on the inner side of the limb. In the non-hereditary group, reckoning the first case as one, it appeared in 7 cases on the outer side, and in 7 cases on the inner side, as an

family of 8 brothers and 3 sisters, 3 brothers and one sister were born with digital increase. Two had an additional outer toe, one an additional outer finger, one had it on all the four limbs. It was unknown in the family as far back, at least, as the great-grand-parents.

* See a paper by the author in the "Edin. Medical Journal," June 1863.

additional thumb. Three of the seven external cases were on feet, on the outer side. In the hereditary group, taken as families, it is on the inner side in the majority of the cases. In one family only [cases 17, 17 (a), 18 (a)] does it affect the big toes. As far as these cases show, it would, therefore, seem to be more common on the outside of the foot, and, on the hand, more frequent on the inner than the outer side. Were we to connect these facts with the facts regarding the order in which the toes appear, or disappear, among the mammalia, we would require to consider not only the fact that the inner digit is the last added, but that the increase, or decrease, takes place alternately on the inner and outer sides.

On the hand, the additional digit was smaller than the next, always so in the case of an additional little finger, and nearly always so in the case of an additional thumb, but in case 18 (a) the two thumbs were equal, and in case 2 nearly equal. On the foot, in cases 12 and 13, the sixth toe is thicker than the fifth, although it has a phalanx less, but the thickness does not seem to depend on the bones. Among the hereditary cases, in case 17 (a) the internal of the two great toes is the larger.

Cases of non-hereditary increase in the number of the digits appear to be of not unfrequent occurrence. Most surgeons have met with cases, and it is a common practice to remove the additional digit early. The above cases show that the removal of the digit, in cases in which it is inherited, does not eradicate the atavic influence. But most of the cases of original variation do not appear to transmit the tendency, for, besides the facts mentioned in some of the cases, cases of original variation are much more common than hereditary cases, even reckoning each member of the existing family as a separate case.

Hereditary Transmission of the Variety.—The transmission of a newly acquired variety has to depend on whether the new influence or the prior normal influence proves the stronger; and, if the former prevails, it has, so long as only one parent presents the variety, farther to depend for its continuance on its chance of the fact that one parent may exert more influence than the other on some of the young. Thus if not itself at the beginning overcome by

atavism, it is liable to be lost at every new union, and, we would suppose, liable to be worn out at last. The case of the L—— family (case 15) illustrates various phenomena of variation and transmission. (1.) In the line of descent through Andrew L——, we see three successive generations without the variety, and it is apparently extinguished. (2.) In the line through James L——, he and his children were normal, but it re-appears in his grandchildren, having passed over two generations. In case 19, it had passed over three, and in case 16, over at least two, generations. In case 18 (a) although the grandmother's brother had it, the great-grandparents had not, so that it had passed over three generations in the direct line and reappeared in the fourth.

(3.) We see uninterrupted transmission in the line of descent through John L——, from Esther in the first (if she was the first), to Jane in the fourth generation. The six-fingered tendency had here maintained itself against three successive unions with five-fingered persons. In the first offspring it succeeded, as far as we know, in only one out of 18. In the offspring of this one (Charles L——) it succeeded in 3 out of 12. In two of these three it did not appear in the next generation; in the third of them it succeeded in one out of two children, thus being directly transmitted to the fourth generation.

It is interesting to notice, too, how the variety so far from being weakened had gathered force in each new generation, even although it had not the advantage of the greater development attending utility, to enable it to increase its hold on the organism. In the first known ancestor (case 15) it occurred on one hand; in the second generation on both hands; in the third on both hands of two brothers, and on both hands and one foot of a third brother; and in the fourth generation on all the four limbs—thus, so far from becoming weaker, making its way to an additional limb in each successive generation.

Besides thus extending itself symmetrically and serially, it may extend in depth, beginning as one phalanx and extending at length to the metacarpal or metatarsal region. In some of the cases of original variation, there was only

one phalanx, in most of them two phalanges. Among the hereditary cases, in case 19 (*a*) there is a metacarpal bone besides two phalanges; and, in case 18 (*a*), the same occurs in both hands, while on the six-toed foot it has not extended to the metatarsal bone. In case 17 (*a*) one of the thumbs on each hand presents three phalanges without an additional metacarpal, while the two great toes have, on both feet, two phalanges each, and one foot has an additional metatarsal bone. In case 17 there is an additional metacarpal bone and three phalanges. We do not know how it was with the ancestors of these cases, but in none of the cases of non-hereditary variation did it extend so deeply into the limb.*

When the variety is transmitted it is on the same side of the limb. In case 15, the additional digit was external, both on the hands and feet, in all the ramifications of the descent. Also in case 20. In cases 17, 17 (*a*) 18, and 18 (*a*), in which the variety is derived from a common ancestor by different lines of descent, it is on the inside of the hand or foot, or on the inside of both hand and foot. Also in case 16. In none of the cases was it external on one limb and internal on another limb of the same person, or in the same family. In case 8, of two children in the same family, one had an additional little finger, the other an additional thumb, but the case is one of the non-hereditary group, and there is the curious fact that they were the children of different fathers, though of the same mother. The influence of sex does not appear to any marked extent in the hereditary transmission in the above cases.

Diminution in the Number of the Digits.—Diminution in

* When the additional digit is supported, as it generally is when well formed, on one end of a more or less bifurcated metacarpal or metatarsal bone, it might be supposed that this indicated the original presence of an additional metacarpal or metatarsal bone, which had become more or less confluent with the next, as in the development of the metacarpus and metatarsus in the ruminant. But while this can be easily shown in the ruminant, there is no proof that here there is anything but a more or less extensive bifurcation of one bone. In the dissection of the left foot in case 21, in which the fourth and fifth toes were partially united and supported on one metatarsal bone, the fifth metatarsal being wanting, the fourth metatarsal was twice the normal thickness, but presented no trace of double origin, externally or internally, although the foot was that of a new-born child.

the number of the digits appears to be a much less frequent variation than increase, both in man and in mammals generally, although many mammals have normally less than five. Among these the occurrence of an additional digit is generally but the development of the concealed rudiment of a suppressed digit. In man, although he normally possesses the full mammalian number, the tendency is to farther increase rather than to decrease in the number.

Variation in the Number of Phalanges.—In this group of cases there was diminution of the number of phalanges in four cases, in none of which was it hereditary, although one of the cases embraces two brothers and a sister.*

From cases 23, 24 and 25, in which the fingers were more or less rudimentary, while the thumb was either not at all or less reduced, it would seem as if the thumb were the last to suffer reduction. Two cases have been mentioned to me, however, although I have not seen them, in which the thumb alone is wanting, in one of the cases on both hands. Homologically considered, we would expect

* See a case of hereditary transmission of deficient phalanx by Alf. Robert, mentioned in an able paper by Mr Sedgwick "On the Influence of Sex in the Hereditary Transmission of Disease" (*Brit. and Foreign Med. Chir. Review*, April 1863). Also a case by Dr Kellie of Leith (*Edin. Med. and Surg. Journal*, 1808, p. 252); but the mother's statement that it had been transmitted for ten generations must be received with caution, when we consider what ten generations implies. Among the more interesting cases of hereditary transmission of increased number of digits on record are—The case of the Maltese family, by Commander Godehew (*Mémoires de l'Académie Royale des Sciences*, 1751), more fully related by Reaumur (*L'Art de faire eclorre et d'élever des Oiseaux Domestiques*, tom. ii. p. 377): The case by Sir A. Carlisle (*Philosophical Transactions*, London 1814, p. 94): A case by Dr Crawford of Peebles (*Edinburgh Monthly Journal of Medical Science*, Oct. 1851, p. 356): A case by Mr J. B. Thomson of Perth (*Edin. Medical Journal*, 1858–59, p. 502); and a case noticed in "Medical Times and Gazette," Dec. 20, 1860, from the "American Medical Times," possibly a branch of the family whose case is related by Sir A. Carlisle. On this subject may be also consulted, Haller (*Elementa Physiologiæ*, t. viii. pp. 97, 98, 99, 1766): Morand (*Mem. de l'Acad. des Sciences*, 1770): Isodore Geoffroy St-Hilaire (*Histoire Générale et Particulière des Anomalies de l'Organisation*, 1832–36): and A. W. Otto (*Monstrorum Sexcentorum Descriptio Anatomica*, 1841). The oldest recorded case is that of one of the sons of the giant of Gath (2 Samuel, ch. xxi., v. 20; and 1 Chronicles, ch. xx., v. 6) who had six fingers on each hand and six toes on each foot. Pliny notices two cases, among the Romans, of six fingers on each hand (XI. Book, ch. 43). Anne Boleyn is said to have had six fingers on each hand.

the thumb to be the first, teleologically considered, the last, to suffer reduction.

Increase in the number of phalanges occurs in the thumb only, or as in cases 17 and 17(a), in the digit serially corresponding to the thumb when six digits are present. None of the cases presented a higher number than three, the full number in the mammalian type. Case 26, in which, without any increase in the number of the digits, the thumb presents an additional phalanx, is a very remarkable one when we consider the mammalian law. Not unlikely, it may have been the same in the father of cases 17 and 17 (a), who is described as having had very long thumbs, while his son and daughter had three phalanges in the corresponding digit, and a thumb with two phalanges added by its side.

On the absence of a Bone in the Thumb and great Toe, as compared with the other Digits ; and on the Nature of the " Metacarpal " or " Metatarsal " Bone of the Internal Digit.

The occurrence, normally, of a bone less in the thumb or great toe than in the other digits, is part of a law exemplified in the inner digit of all five-toed mammals,* and may be supposed to find its explanation in the fact that the internal is the small toe, and the one which has disappeared when the number is reduced to four. Whatever be its meaning, this law is maintained in the few cases in which the internal digit undergoes great teleological development, as in the seal and walrus,† in which the internal digit is longer and thicker than the three middle digits, and in

* This law is not without exception in cases of variation, as in case 26 ; and I have lately been presented by Mr Robertson of Kelso with a pig's foot, presenting five toes, in each of which there are three phalanges besides the metacarpal bone.

† I have seen a skeleton of the walrus with three phalanges in the pollex, but on trying with my penknife, I found one of them to be a piece of wood. In the skeleton of a seal I once saw three natural phalanges in the inner digit, but the first and fifth toes had been transposed. The phalanges and metacarpals and metatarsals of the seal are arranged and developed exactly as in man, and the presence of only two phalanges in the pollex and hallux is easily felt in the living seal.

man in whom the great toe and thumb are the most important of the digits. As the erect posture requires a great toe on the inner side of the foot, and a long one, the phalanges of the inner digit are, accordingly, developed in length as well as in thickness. The thumb, again, being better adapted for opposition by being shorter, is developed in thickness, and still retains its character as the shortest digit.*

It has long been a discussion in human anatomy, whether the wanting bone in the thumb and great toe is a phalanx or a metacarpal or metatarsal bone. The view that it is the middle phalanx which is wanting is supported by the arrangement of the muscles,—(a.) by the absence of the *tendo perforatus*; (b.) by the attachment to the first phalanx of the short muscles which correspond to the short muscles of the little finger, which are attached to its first phalanx; (c.) by the attachment to the metacarpal bone (with its resulting prismatic form) of the muscles which correspond to those which are attached to the metacarpal bone of the little finger; and (d.) by the position of its metacarpal bone in the metacarpal range.

Opposed to this view is the one fact, that the so called metacarpal bone of the thumb is developed like a phalanx, having its epiphysis at the proximal end, while the other metacarpal bones have their epiphyses at the distal end. The discussion stood there, the difficulty being to say what value should be given to the developmental fact. There might be some special reason for the changed position of the epiphysis, although it would be difficult indeed to suggest any such reason, either on the longitudinal growth, or on the elasticity, theories of the use of epiphyses, especially

* I have been in the habit of pointing out the interesting fact, that the relative length of the digits on the human hand indicates the order in which the digits disappear in the downward progression from the five to the one toed mammal,—the internal disappearing first, next the external or fifth, next the index or second, lastly the ring or fourth,—the extreme digit disappearing on alternate sides, beginning on the inner, until the middle digit alone remains in the foot of the horse, as demonstrated by Professor Owen in his work “On the Nature of Limbs.” Nor need this correspondence be regarded as a mere coincidence, when we consider the relative function of the digits in an ordinary five-toed limb. The exceptions presented to this, in the human foot, and in the lateral toes of the pinnigrade carnivora, are special adaptive modifications of certain digits.

in the case of the great toe, the distal end of whose metatarsal bone is the most developed. Comparative anatomy, however, sets this question at rest. I find that the distal position of an epiphysis on a metacarpal and metatarsal bone, and its proximal position on the phalanges, belongs to other mammalia as well as to man, and is adhered to notwithstanding the most varied proportionate size which the two kinds of bones, or their two ends, attain.* In the horse and ruminant, in which the great metacarpals and metatarsals attain enormous size, they have still only one epiphysis, while the radius and humerus have an epiphysis at both ends; and the metacarpals and metatarsals have their epiphysis distal, while on the phalanges it is proximal. The short and flat thigh-bone of the seal has epiphyses at both ends, while the greatly elongated metacarpals, metatarsals, and phalanges, have but one epiphysis each, placed as on the corresponding bones in the human hand and foot. A still more striking example of this law is presented in the development of the rudimentary metacarpals and metatarsals of the horse; the large upper ends of which, serving an articular function, are developed without an epiphysis, the epiphysis being kept for the little "button" which terminates the tapering lower end. The more we compare the muscles of the two limbs, and in the limbs of different animals, the less dependence do we place on their attachments for the determination of homology; and the above facts in comparative osteogeny show, that the position of the epiphysis is decisive in establishing the view that the bone which is wanting in the human thumb and great toe, and in the internal digit of other five-toed mammals, is the metacarpal and metatarsal, although custom and convenience lead us to apply these terms to the bone which homologically is the proximal phalanx.

* The cetacea present an exception to the mammalian law of three phalanges, in the occurrence of more than three in the longer digits of the paddle, making an approach in this respect to the digital type of the fish. I have observed that the cetacean digits present another exception in the presence of epiphyses at both ends of each phalanx, and also at both ends of the metacarpal bones. In contrast with this, we have the great distal phalanx of the horse, ruminant, pig, and some others, developed without an epiphysis, while in man it is present on the distal phalanx as well.

Extract from Report of the Royal Commission (consisting of Professor LYON PLAYFAIR, C.B., Professor HUXLEY, and Lieut.-Colonel MAXWELL) on the Operation of the Acts relating to Trawling for Herring on the Coasts of Scotland.

Natural History of the Herring.

Before proceeding to sum up our conclusions from the preceding inquiries, it will aid us to take a general survey of the natural history of the herring, so far as it relates to the practical questions now under consideration.

The herring is found under four different conditions: 1st, *Fry* or *Sill*; 2d, *Maties* or *Fat Herring*; 3d, *Full Herring*; 4th, *Shotten* or *Spent Herring*.

The first term is applicable to all herring which are not larger than sprats, or, in other words, are under five or six inches in length. The milt and roe in fish of this size are so small as to be discoverable only by careful dissection.

The fry pass imperceptibly into *Maties*, which may have any length from six inches to thirteen, the last admeasurement being the extreme length of any British herring which has come under our notice. Internally, a matie is characterised by two peculiarities: the one being the great quantity of fat deposited about the alimentary canal; the other the small size of the roes or milts, which never quite fill the abdominal cavity, and, in herrings under ten inches, rarely exceed two or three inches in length, though they are always readily discernible.

A *Full herring* is one in which the milt or the roe is fully developed, so as to occupy the whole of the abdominal cavity, except the small space filled by the intestine; while the fat around the intestine has disappeared, having in all probability been applied to the nutrition of the reproductive organs.

The smallest full herring which has come under our own observation was a female, measuring $10\frac{4}{10}$ inches in extreme length, taken in Loch Fyne; but we have been assured by very competent and trustworthy informants, that full herrings not more than seven or eight inches long have been taken at several points of the west coast of Scotland. The largest British full herring which we have had under our direct observation was $12\frac{6}{10}$ inches long; but Mr Gibson, Fishery Officer at Broadford, Skye, through whose hands immense numbers of herrings passed when he was in the employment of the late Mr Methuen of Leith, assured us that it is by no means an unfrequent occurrence to find fish 14 or 15 inches long among the Orkney herrings, and that he once measured one which had attained the surprising length of 17 inches.*

* Mr Methuen himself states that Iceland herrings are generally 17 inches long.





We have measured two maties from Labrador, respectively $13\frac{1}{2}$ and $13\frac{9}{10}$ inches long; while Mr Mitchell, in his valuable essay on the herring, states that the Norwegians have a considerable fishery at Stadland, where they generally get very large herrings, few being under a foot in length, and many 15 inches.

Hence it is quite safe to assume that adult full herrings may vary in length from 10 inches to 15, while it is possible that they may vary from 7 inches to 17 inches. There is nothing really remarkable about this, as other fish vary in dimensions in their adult state to fully the same extent,—a consequence of their continuing to grow long after they have reached the age at which they are capable of propagating their kind.

It has been frequently asserted, and evidence has been repeatedly laid before us to the effect, that particular lochs on the west coast of Scotland, such as Loch Broom and Loch Hourn, are inhabited only by herrings of a size smaller than the average; but, on the other hand, equally trustworthy evidence has directly negatived these assertions, the witnesses on this side affirming that the herrings of these lochs differ in no appreciable respect from those met with in other localities. We can give no opinion on this subject, as the time at our disposal was necessarily employed in investigating matters more directly relevant to the objects of the Commission.

When the herring first attain the full condition, the roe or the milt, as the case may be, is firm and hard; and pressure upon the belly of the fish will not give rise to the extrusion of ova, or seminal fluid, from the apertures of the reproductive organs. But the texture of the latter rapidly becomes softer, and soon acquires a semi-fluid consistency, so that the slightest pressure causes the reproductive elements to pass out of the body.

If a female in this state be squeezed, and the ova received into a vessel full of sea-water, they will all fall to the bottom; and the viscid substance, with which the ova are coated, causing them to adhere together, forms a thick cake, which, after a few hours' rest, constitutes a dense consistent mass, so firmly adherent to the bottom of the vessel that the latter may be suddenly inverted without detaching the ova. Indeed, to separate these either from one another or from the body to which they adhere, demands the exertion of a certain force, which as often ends in the destruction of the eggs as in their detachment.

It would seem as if all the superfluous nourishment in the body of the herring were applied to supply the rapid increase of the reproductive organs; for *shotten*, or *spent herrings*, so called because their roe and milt are completely emptied of their contents, not only have no fat about their intestines, but even their muscular substance is almost devoid of fat, and is consequently harsh, dry,

and insipid when cooked. They are distinguished from maties not only by this circumstance, but by the fact that the roe or milt, though greatly shrunk, may be restored to nearly the size of those of a full herring by inflating them with air, whereas the reproductive organs of a matie cannot be enlarged in any such manner.

It is extremely difficult to obtain any satisfactory evidence as to the length of time which the herring requires to pass from the embryonic to the adult or full condition. Of the fishermen who gave any opinion on this subject, some considered that a herring takes three, and others that it requires seven years, to attain the full or spawning condition; others frankly admit that they knew nothing about the matter; and it was not difficult, by a little cross examination, to satisfy ourselves that they were all really in this condition, however strongly they might hold by their triennial or their septennial theories. Mr Yarrell and Mr Mitchell suppose, with more reason, that herring attain to full size and maturity in about eighteen months.

It does not appear, however, that there is any good evidence against the supposition that the herring reaches its spawning condition in one year. There is much reason to believe that the eggs are hatched in, at most, from two to three weeks after deposition, and that in six or seven weeks more (that is, in, at most, ten weeks from the time of laying the egg), the young have attained three inches in length. Now it has been ascertained that a young smolt may leave a river and return to it again in a couple of months, increased in bulk eight or ten fold; and as a herring lives on very much the same food as a smolt, it appears possible that it should increase in the same rapid ratio. Under these circumstances, nine months would be ample time for it to enlarge from 3 to 10 or 11 inches in length. It may be fairly argued, however, that it is not very safe to reason analogically from the rate of growth of one species of fish to that of another; and it may be well to leave the question, whether the herring attains its maturity in twelve, fifteen, or eighteen months, open, in the tolerably firm assurance that the period last named is the maximum.

Yarrell, Valenciennes, and all the best authorities upon the herring, agree that the account of the migrations of the herring from and to the seas within the Arctic circle, promulgated by Anderson and Tennant, is wholly devoid of evidence. The herring fry frequent the lochs and shallows of the sea upon the British coasts in shoals, sometimes by themselves, at other times mingled with sprats, feeding upon the minute crustacea which throng the waters, and gradually growing into maties. Whether they betake themselves into deeper water on assuming the latter condition, or merely pass from a gregarious into a solitary state, does not

appear to be clearly made out. But the large shoals of herrings which appear upon our coasts in the early summer and in the late autumn months, and which seem to come from deeper into shallower water, are at first either entirely composed of maties, or contain a very large proportion of them.

The maties feed, develop their reproductive organs, and become full herring in the course of about three or four months, the full herring appearing, at first, only scattered here and there among the shoals, but gradually increasing in number, until they largely preponderate over the maties, or almost entirely constitute the shoal. The herrings then frequently aggregate for about a fortnight, in most prodigious numbers, in particular localities, like the Banks of Ballantrae, and the Traith or Fluke Hole, which are suitable, from the character of the bottom or from other circumstances, for the reception of their ova. Here they lie in tiers, covering square miles of sea bottom, and so close to the ground that the fishermen have to practise a peculiar mode of fishing in order to take them; while every net and line used in the fishing is thickly covered with the adhesive spawn which they are busily engaged in shedding. So intent are the fish on this great necessity of their existence, that they are not easily driven from their spawning ground; but when once their object has been attained, and they have become *spent fish*, the shoal rapidly disappears,—the universal and very probable opinion of fishermen being, that they withdraw into deep water, at no great distance from the coast. There is no positive evidence as to the ultimate fate of the spent herrings; but there is much to be said in favour of the current belief, that after a sojourn of greater or less duration in deep water, they return as *maties* to the shallows and lochs, there to run through the same changes as before, passing a second time from the condition of *matie* to full herring, and from *full* to *spent*. Of the manner in which the change from the *spent* to the second *full* state is effected we know nothing, nor have we any information respecting the number of times which one and the same herring may run through the cycle. However, the enemies of the fish are too numerous and too active to allow us to suppose the existence of any one individual to be prolonged beyond two or three reproductive epochs. It is probable that the difference of age, whatever it may be, is sufficient to account, in great measure, for the varying size of adult herrings.

Singularly contradictory statements are to be met with respecting the spawning season of the herring. We have obtained a very large body of valuable evidence upon this subject, derived partly from the examination of fishermen, and of others conversant with the herring fishery; partly from the inspection of the accurate

records kept by the Fishery Officers at different stations,* and partly from other sources; and our clear conclusion from all this evidence is, that the herring spawns at two seasons of the year, viz., in the spring and in the autumn. We have hitherto met with no case of full or spawning herring being found in any locality during what may be termed the solstitial months, namely, June and December; and it would appear that such herring are never (or very rarely) taken in May or the early part of July, in the latter part of November or the early part of January. But a spring spawning certainly occurs in the latter part of January, in February, in March, and in April; and an autumn spawning in the latter part of July, in August, September, October, and even as late as November. Taking all parts of the British coast together, February and March are the great months for the spring spawning, and August and September for the autumn spawning.

It is not at all likely that the same fish spawn twice in the year; on the contrary, the spring and the autumn shoals are probably perfectly distinct; and if the herring, according to the hypothesis advanced above, comes to maturity in a year, the shoals of each spawning season would be the fry of the twelve-month before.

However, no direct evidence can be adduced in favour of this supposition; and it would be extremely difficult to obtain such evidence.

The food of the herring consists of crustacea, varying in size from microscopic dimensions to those of a shrimp, and of small fish, particularly sand eels. While in the matie condition, they feed voraciously, and not unfrequently their stomachs are found immensely distended with crustacea and sand eels, in a more or less digested condition.

Herring thus abundantly fed are apt to have all their tissues so permeated with fat that they will not cure well, and their flesh is liable to break when handled. The Scotch fishermen style such as these "gut-pock" herring,† and consider them of very inferior quality.

The Possible Effects of Legislation on the Breed of Herring.

The herring is a notoriously variable fish, appearing in the most prodigious shoals, year after year, at a given point of the coast, and then suddenly diminishing in number, or even utterly

* The intelligent Fishery Officers might be made highly useful by keeping natural history registers on a systematic plan, and results important both to science and practice might thus soon be obtained.

† These seem to be the "Harengs à la bourse," or "Harengs aboutifs," of the French fishermen.

vanishing for a long period. The chief reason of these variations is probably to be sought in the variation, 1st, of the quantity of food of the fish; 2d, in the number and force of the destructive agencies at work upon it.

Any circumstance which increases or decreases the quantity of crustacea and of sand eels, for example, must influence in a direct ratio the chances of existence of a multitude of herrings; while any condition which increases or decreases the number or the activity of the enemies of the herring, must influence those chances in an inverse ratio.

Leaving out of consideration the animals which prey upon herring fry, and their mere accidental and unimportant enemies, their great destroyers are,—

a. *Fish.*

Cod, ling, coal-fish, hake, conger, dog-fish.

b. *Birds.*

Gulls and gannets.

c. *Marine Mammals.*

Porpoises and other cetacea.

d. *Man.*

The following considerations may help us to form an estimate of the relative importance of these different destructive agencies:—

In 1861, there were in Scotland, and that part of England over which the Fishery Board have jurisdiction, 42,751 fishermen and boys engaged in the herring fishery. The total take of the year would give about 20,000 herrings for each of these persons, or near upon 900,000,000 for the whole.

It seems, and indeed is, a most marvellous drain upon the power of multiplication of one animal, to destroy in one year a multitude exceeding in number the whole human population of the globe. But it may be readily demonstrated that this vast number sinks into insignificance if compared with the total destruction effected by agencies over which man has no control whatsoever.

Consider the destruction of large herring by cod and ling alone. It is a very common thing to find a cod-fish with six or seven large herrings in his stomach, of which not one has remained long enough to be digested. If, in order to be safe, we allow a cod-fish only two herrings *per diem*, and let him feed on herrings for

	Herring.	Days.
only seven months of the year, then	$2 \times$	$210 = 420$

herring as his allowance during that time; and fifty cod-fish will equal one fisherman in destructive power. But the quantity of cod and ling taken in 1861, and registered by the Fishery Board, was over 80,000 cwt. On an average, 30 cod-fish go to 1 cwt. of the dried fish. Hence, at least, 2,400,000 cod-fish were caught in 1861.

But if 50 cod-fish equal 1 fisherman, 2,400,000 will equal 48,000 fishermen. In other words, the cod and ling caught on the Scotch coasts in 1861, if they had been left in the water, would have caught as many herring as a number of fishermen *equal to all those in Scotland, and six thousand more*, in the same year; and as the cod and ling caught were certainly not one tithe part of those left behind, we may fairly estimate the destruction of herring, by these voracious fish alone, as at least ten times as great as that effected by all the fishermen put together.

When it is further considered, that the conger and the dog-fish probably do as much mischief as the cod and ling, that the gulls and the gannets slay their millions, and that the porpoises and grampuses destroy additional untold multitudes, it will probably be thought no exaggerated under-estimate if we assume that our fishery operations, extensive as they are, do not effect 5 per cent. of the total destruction of maties and full herring that takes place every year. And when it is further considered, that sea-trout and innumerable other fish prey upon the herring fry, and that flat fish of all kinds resort in immense numbers to the spawning grounds of the herring, to prey upon the freshly-deposited ova, it would seem, as we have said, that the influence of man, whether conservative or destructive, upon herrings must be absolutely inappreciable; and, under these circumstances, it seems almost unavoidable that great fluctuations, wholly beyond human control, should occur in the abundance of herring in different years.

If the herrings in any given year multiply with great rapidity, owing to favourable circumstances, their enemies also will multiply in consequence of their better and more abundant supply of food; and if, as must sometimes happen, the ratio of multiplication of the enemies is greater than that of the herring, the latter will, in that or the succeeding year, be vastly diminished. But the very diminution of the herring necessarily tends to starve down the fish which destroy them, and to throw them open, in a weakened state, to the attacks of *their* enemies, who, by the same law, have necessarily multiplied in consequence of *their* multiplication. By such a concurrence of causes, the herring, relieved from their oppressors, will in a year or two appear again in immense numbers; and so the alternations of prosperity, over-production, and panic in the trade which they originate, will occur with as much regularity as if the herring were manufacturers.

CONCLUSIONS.

Having in the previous part of the Report given our reasons for the conclusions to which we have come, in regard to the sub-

jects of our investigations, it may now be useful to make a brief summary of the results :—

1. Drift-net fishing has been long pursued in this country, as the chief method for the capture of herring.
2. Drift-nets must have a mesh of not less than one inch from knot to knot (48 Geo. III., c. 110, s. 12). In consequence of this regulation, herring fry cannot be caught by this system of fishing.
3. The amount of capital required by the crew of a drift-net boat is considerable. The price of the boat varies, according to its size, from L.20 to L.100 or upwards, and the value of the nets may be equal to that of the boat.
4. The system of seining (improperly called ‘trawling’) for herring was introduced on the West Coast in 1838, but did not become general till 1846. Its operations are chiefly confined to Loch Fyne and its neighbourhood.
5. The system of seining requires much less capital than that of fishing by drift nets. The cost of each trawl skiff is about L.15, two skiffs being used in fishing, and the cost of the seine net is from L.15 to L.20.
6. The practice of using the seine net for herring was rendered illegal in 1851, by the Act 14 and 15 Vict., c. 26.
7. Under special circumstances, the risk of a rupture of the peace being imminent, the Government, but not at the instigation of the Fishery Board, obtained in 1860 increased powers for the repression of trawling by the Act of 23 and 24 Vict., c. 92, and still further powers in 1861, by the Act 24 and 25 Vict., c. 72.
8. These Acts have been effective as means of repression, and seining for herring is scarcely now practised on the West Coast of Scotland.
9. The Act of 1860 established a close time, during which herring are not allowed to be taken. This close time is limited to the West Coast of Scotland, and is fixed from the 1st January to 31st May as far as Point Ardnamurchan, and from thence to Cape Wrath from 1st January to 20th May.
10. There is no close time on the East Coast of Scotland; but the Fishery Board, by the Act of 1860, have power to introduce one,—a power which we recommend should be withdrawn.
11. The curers of herring and the drift-net fishermen approve of the operation of these repressive Acts, asserting that the method of fishing with the seine destroyed the supply

of herring, by scaring the shoals of fish; that immature fish were captured by it; that the spawn beds were injured; that the fish caught by the seine were unfit for curing; and that the seiners or 'trawlers' injured the fishing-gear of the drift-net men.

12. The main question involved in these allegations is the following: Is it an ascertained fact that the system of trawling has injured the fishery of Loch Fyne and its neighbourhood?
13. Our inquiries satisfy us that the fishery of Loch Fyne has suffered no diminution by the operations of the trawlers, but that, on the contrary, it is a steadily progressive fishery, when the periods of comparison are made sufficiently long to correct the annual fluctuations, which are always considerable in this as in all other herring fisheries. The approximate gross take of herring in Loch Fyne, according to the returns of the Fishery Board, are as follows:—

General annual average take from 1833 to 1843, 18,994 barrels.			
„	„	„	1844 to 1848, 15,427 „
„	„	„	1849 to 1853, 19,149 „
„	„	„	1854 to 1858, 25,744 „
„	„	„	1859 to 1862, 42,165 „

14. This steady increase of the fishery, during the period when trawling was practised, cannot be ascribed to an augmentation in the number of drift-net boats; for these, on an average of the same years, with the exception of 1862, show no increase, while the square yards of netting employed remain also comparatively stationary. Hence we are forced to the conclusion, that there have been no grounds for the alarm that the fishery of Loch Fyne was being destroyed by the operations of the trawlers.
14. This result established for Loch Fyne is found to apply to the west coast of Scotland as a whole—viz., that there is a steady increase in the fishery during the periods when trawling was prosecuted, and since it has been abandoned.
15. The selected years of bad fishing, brought as proofs that trawling was destroying the fishery, have, when examined, no application to the question, as an equal number of years of quite as bad fishing are found in every decennial period before the system of trawling had been discovered.
16. The selection of the prosperous year of fishing, 1862, is equally fallacious as bearing on the question. It is only

an instance of the singular fluctuations of the herring fishery. In a period of nearly forty years, the two most productive years have been 1860 and 1862. In the first of these years the second Act of repression was just passed, but trawling was still actively carried on, and had been in more or less active operation for fifteen years. It was only effectually put down by the Act of 1861. The good returns of these two years prove beyond a doubt that trawling has not injured the fishery of Loch Fyne.

17. These conclusions as to the steady increase of the fishery in Loch Fyne, negative the assertion that the trawlers scared away the shoals of fish when entering the lochs.
18. The evidence laid before us, and the experience of the Irish, Norwegian, Newfoundland, and Labrador fisheries, prove that trawled fish, when properly handled, are fit for the purposes of the curer. The reason of their occasional inferiority for this purpose is the reckless mode of pursuing a system of fishing in the constant apprehension of being caught in the violation of the law.
19. Trawling for herring has been an important means of cheapening fish to the consumer, by the large and sudden takes, and has thrown into the market an abundant supply of wholesome fresh fish, at prices which enable the poor to enjoy them without having to come into competition with the curer.
20. It is this circumstance which, in our opinion, has produced the demand for repressive legislation, for the gains of the drift-net fishermen are much affected by the sudden and great captures of the trawler, who, working with less capital, and with a more productive kind of labour, is able to undersell the drift-net fisherman, and to derange the market for the curers. It is to be observed, that as facilities of locomotion and transport increase, the market for fresh fish becomes more important than that for salt fish, and the former suffers if any special protection be afforded to the latter. As regards Loch Fyne, the number of barrels of herrings sold fresh already considerably exceeds that cured. From 1844 to 1853, 55,247 barrels were cured, and 77,137 barrels were consumed in a fresh state. From 1854 to 1862, 129,000 barrels were cured, and 168,530 barrels consumed fresh.
21. The demand for repressive legislation is only another form of that which always arises when a new and more pro-

ductive form of labour presses inconveniently upon those who prosecute and have embarked their capital in the old and less productive form of labour.

22. Although recent legislation has been in logical sequence of that which has long prevailed, and may, in the absence of new inquiries, have been requisite to prevent disturbance of the peace, still, as it proceeds on the assumption that it is justifiable for the conservation of the breed of herring, we are bound to state that, in this point of view, the repressive Acts of 1851, 1860, and 1861, were altogether unnecessary; that they are essentially Acts for protecting class interests, and interfere with the invention and application of new and more productive modes of industry.
23. We are of opinion, that if any legislation had been requisite, it should have only been in the same direction as that applied to the herring fishery generally, viz., to a regulation of the size of the mesh of the seines, which were frequently used under the legal standard. We express no opinion as to the necessity of restricting the size of the mesh generally, as this question is not referred to us under our Commission.
24. If the seine fishing be again rendered legal, increased powers for regulating the police of the fisheries should be given to the Fishery Board.
25. A discretionary power should be vested in that Board to prohibit seining from being prosecuted in waters which are too narrow for that and drift-net fishing being peaceably carried on simultaneously. We are of opinion that Upper Loch Fyne, *i.e.*, above Otter Spit, is too narrow for this purpose, and that the Kyles of Bute offer another instance in which it would be desirable to give the Fishery Board discretionary powers to prohibit the practice of seining, but merely as a question of police.
26. Although we have been unable to satisfy ourselves that a close time is of any advantage for the protection of the herring, still, as it is universally approved of in the district round the Firth of Clyde, we do not take upon ourselves to recommend, against the wish of those who are practically concerned in the fisheries, any alteration as regards this district. It is true that close time presses heavily on the long line fishermen, who are unable to obtain herring for bait to catch white fish during the close time from the 1st January to the 31st May; but it would be possible in this locality to allow licensed boats to catch

fish for bait; and the general desire of all witnesses examined by us is, that the Board of Fishery should be allowed to license such boats under proper regulations. We make this suggestion, however, purely in deference to the state of public feeling in the district in question. The establishment of any system of licensing boats for the capture of bait would, in the long run, involve the taxation of the community for the support of the officers by whom this fishery is superintended, and a further tax on the long-line fishermen, who could obtain their bait more cheaply if they were allowed to procure it for themselves. We do not pretend that it is strictly justifiable to tax the community in general, or one particular branch of industry, to foster another; but in the prevalent state of public feeling about the Firth of Clyde, the method proposed is the only practicable means of alleviating the injustice of close time, as regards the persons engaged in the long-line fisheries.

27. We are of opinion that there is not the slightest necessity for retaining a close time in any part of the coast north-west of the Mull of Cantire. The advocates for a close time in the extensive coast line between this and Cape Wrath desire a period different for each locality, and for reasons entirely dependent on class interests, and having no relation whatever to the protection of the herring. We recommend, therefore, that the coast line from the Mull of Cantire to Cape Wrath should be made as free as the whole east coast of Scotland.
28. In coming to this conclusion, we have taken into consideration the various destructive agencies to which the herring is subject, and of which man is certainly the least destructive. The effect of the recent legislation has been to promote an increase of the major destructive agencies in the sea.
29. By prohibiting the use of herring for bait during the close period from 1st Jan. to 31st May, the white fish, like cod and ling, have been allowed to multiply. A single herring used for bait is employed to catch three of these fish, each of which, if left in the sea, would have devoured annually at least between four and five hundred herring.
30. The cod and ling actually caught and cured on the Scotch coasts in 1861 would, if left in the sea, have destroyed more herring than 48,000 fishermen. As only 42,751 fishermen and boys were engaged in fishing in that year, the magnitude of this destructive agency will be readily per-

ceived. The close time which diminishes the capture of such fish must necessarily prove destructive to the herring.

31. When we further consider that the cod and ling caught represent only a small proportion of those which remain in the sea, and when we recollect that these fish are by no means the most voracious for herring, but that the latter have to struggle for existence, not only with larger fish, but with birds, such as gulls and gannets, and with porpoises, and other cetacea, man, as an element of either conservation or destruction, must produce an inappreciable effect.
32. Under such circumstances, the herring fishery should not be trammelled with repressive Acts, calculated only to protect class interests, and to disturb in an unknown and possibly injurious manner the balance existing between the conservative and destructive agencies at work upon the herring. If legislation could regulate the appetites of cod, conger and porpoise, it might be useful to pass laws regarding them; but to prevent fishermen from catching their poor one or two per cent. of herring in any way they please, when the other 98 per cent., subject to destructive agencies, are poached in all sorts of unrecognised piscine methods, seems a wasteful employment of the force of law.
33. We conclude by expressing our strong conviction that the recent legislation on the subject of the herring fishery has unnecessarily restricted the operations of fishermen,—has repressed invention, by prohibiting new and more productive forms of labour,—is calculated to be destructive, rather than conservative, in relation to the future supply of herring; and although it may be beneficial to certain class interests, is prejudicial to the consumer of fish, and to the public generally.

The Place and Power of Natural History in Colonisation; with special reference to Otago (New Zealand).* By W. LAUDER LINDSAY, M.D., F.R.S. Edin., F.L.S. and F.R.G.S. London, &c. (Concluded from last Number.)

Geology of the Otago Lignites.

Nearly as many queries have been put to me regarding *coal* as regarding *gold*. What do I think, I am asked, of the Clutha coal, the Saddlehill coal, the Tokomairiro coal, and others of the so-called coals of Otago? In reply, I regret I cannot regard any of your so-called coal, *which I have seen*, in the same favourable light that Government and the settlers generally appear to do. I say so now, and frankly, because I fear great disappointment, and, very probably, great losses in speculation may be the result of exaggerated or erroneous notions of the value of the coals referred to. There are questions connected with the commercial value of your coals—(or let me call them by what appears to me to be their proper name, *Lignites*—I prefer using the true designation, for reasons immediately to be explained)—with which, at present, I have nothing to do; such are the distances of the respective coal fields or workings from Dunedin or other market, the difficulty and cost of transport, the scarcity and expensiveness of labour, and so forth,—all of which, however, are matters of moment to speculators and consumers. But I would enter on certain brief explanations as to the geological position and characters of your lignites. Without going into the strict scientific definition of “what is coal”—a theme of much greater intricacy than you may suppose, and the subject of one of the most interesting suits that has been tried before the Court of Session in Scotland of late years—the celebrated Torbanehill mineral case—it is enough for present purposes to say that the substance we at home call Coal, belongs to, or is contained in, a particular formation or system of rocks called by geologists the Carboniferous, or coal-bearing, system. The position and the components of this series of strata are well defined; geologists know precisely the rocks above and below. The character of the fossils especially it is, vegetable or animal, which a rock contains—a fern frond, a fish-tooth, a shell,—which enables the geologist with certainty to identify strata, and at once to fix the system to which they belong—their place in the geological series or chain—their comparative chronology. And it is fortunate we possess

* Extracts from a Lecture prepared for, and at the request of, the “Young Men’s Christian Association” of Dunedin (Otago, New Zealand). Dunedin, January 1862.

such an infallible, or at all events comparatively accurate, index; for the mere mineral characters are often utterly insufficient. For instance, there is a red sandstone above and another below the Coal Measures, the one called the *New Red* and the other the *Old Red Sandstone*, in reference to their comparative ages,—alike in regard to mineral characters, that is as to colour, composition, and texture. The novice cannot tell the one from the other; but the palæontologist—the expert who is conversant with the fossils which characterise the earth's strata—can at once say which is which. Knowing that the geological position of the Coal Measures is between these two series of rocks, the man of science would never be so stupid, nor so rash, as to be at the trouble and expense of sinking coal-pits through the Old Red Sandstone in the hope of finding coal; while he would do so through the New Red with every probability of success. But, look at the position of the landowner or coal speculator ignorant of these elementary facts in geology. He may ruin himself by sinking shafts through the Old Red Sandstone, for a mineral which *cannot* be found below it; or he may lose a fortune should he mistake the New Red for the Old Red Sandstone, by refraining from digging where coal may with every probability be found. This is no hypothetical case; I have known landowners ruining and stultifying themselves by boring or sinking shafts for coal through the Old Red Sandstone on the Perthshire base of the Ochils in Scotland. I have already quoted the familiar adage—"All is not gold that glitters." Neither, may it be equally truly added, is every rock that is black coal! There is no lack of black rocks in the earth's crust; many shales are sufficiently black and carbonaceous: they contain more or less vegetable matter, yet are they not coal, nor do they belong to the Carboniferous system. The Silurian slates, for example, are frequently very black and carbonaceous, quite as much so as many shales of the true coal measures; they are so where I have examined them in the neighbourhood of Dumfries. Now the Silurian system is inferior in the geological scale to the Old Red Sandstone; and if no coal is to be found below the latter, still less will it be found below the former. Led astray, however, by the coal-like aspect of such shales—having confidence in their own judgment and cunning, ignorant altogether of geology, too parsimonious to spend a few guineas on a survey and report from a mining geologist—I have heard of Dumfriesshire lairds ruining themselves by expensive borings through these same Silurian slates. The late Mr Rose, consulting geologist, Edinburgh, I have heard tell many stories of the same kind; sufficiently numerous instances occur, indeed, in the experience of all practical geologists.* Such cases, indeed, are the

* Let me here cite the testimony of what is at once the most recent and (according to the "Edinburgh New Philosophical Journal" for Oct. 1862, p.

commonest illustrations of the *loss of money by geological ignorance*. But not only are such cases frequent *at home*; they would appear to be equally so much nearer your own shores; so notoriously so indeed as to have found the following record in the pages of a popular topographical handbook (Fairfax's "Handbook to Australasia," 1857, p. 14, Victoria):—"Considerable sums, which might have been saved by a very small amount of geological knowledge and investigation, have been injudiciously and *fruitlessly expended*, both in the Cape Patterson, Cape Otway, and Barrabool Hills districts, in searching for workable seams of *coal*." True coal, then—the coal we use as fuel in Scotland and England—belongs to the "Carboniferous system" of geologists. A limited amount of coal, whether properly or improperly so-called I cannot stop here to inquire, occurs, *inter alia*, in the Permian, Triassic, Jurassic, and Cretaceous systems, all of which are superior in the geological scale to the Carboniferous system. Another substance called *Brown Coal* or *Lignite*—usually the latter—is peculiar to the Tertiary formation, a formation still more recent, still higher in

290) "the best Manual of Geology in the English language"—"The Student's Manual of Geology, by J. Beete Jukes, F.R.S., Director of the Geological Survey of Ireland: Edinburgh, 1862." "I have elsewhere stated my belief," says Mr Jukes, "that the amount of money *fruitlessly expended* in a ridiculous search after Coal, even within my own experience, would have paid the entire cost of the Government Geological Survey of the United Kingdom. It is a curious perversity of the human mind, that men prefer to take the advice of those whose interest it is to get them to spend money, rather than the warnings of those who can have no interest in inducing them not to spend it. . . . Within my own experience large sums of money have been *absolutely thrown away*, which the *slightest acquaintance with Palæontology would have saved*. I have known, even in the rich coal district of South Staffordshire, shafts continued down below the coal measures, deep into the Silurian shales, with crowds of fossils brought up in every bucket, and the sinker still expecting to find coal in beds below these Silurian fossils. I have known deep and expensive shafts sunk in beds too far *above* the coal measures for their ever being reached; and similar expensive shafts sunk in black shales and slates in the lower rocks far *below* the coal measures, where a pit might be sunk to the centre of the earth without ever meeting with coal. Nor are these fruitless enterprises a thing of the *past*. They are still going on in spite of the silent warnings of the fossils in the rocks around, and in spite of the loudly expressed warnings of the Geologists, who understand them, but who are supposed still to be vain theorists, and not to know so much as the 'practical man.' . . . All 'indications' are worthless as evidence of the presence of the 'Carboniferous formation,' except the occurrence of the 'Carboniferous fossils.' Even where the fossils occur, there may be no coal; but all sinking for coal in beds containing any other than the Carboniferous fossils is *pure waste of labour and money*. . . . The geologist . . . knows that not only do black and grey shales occur where there is no chance of coal being found; but that even thin seams of coal occur in formations where no coal worth working has ever been found in the British area or in western Europe. . . .

"The importance of the study of *fossils* . . . is not limited to the theoretical speculations or the philosophical conclusions that may be derived from them; for these, like many other scientific conclusions, *may be coined into actual money, or money's worth, by their practical application*."

the geological scale. It hardly occurs to any extent in Britain; but it is abundant in some parts of Germany, and in Iceland it constitutes the “Surturbrand,” of which I have seen specimens very like those of the Otago lignites. To this class of rocks—to the *tertiary lignites*—belong, in my opinion, all the so-called *Otago coals* I have as yet seen. I have traced the formation of your lignite from the state simply of decayed wood to that of a black coal-like mineral, in the cliffs near the Coal Point at the mouth of the Clutha; and I have seen it in process of formation at the present day in a well sinking at a depth of some 40 or 50 feet in the swamp-clays of Dunedin. The origin of these lignites seems comparatively recent: they have not been subjected to the same enormous pressure as the Carboniferous system coals, occurring as the former do mostly on or near the surface. Nor do they seem composed of the same materials—at least in the same proportions: chemically, their constitution is not precisely the same; in heat-giving, gas-giving, and steam-giving power, they are likely to prove inferior to the true coals, with which they will not probably be able to compete.* Should all the coals of Otago belong to the family of the tertiary lignites, I fear you must be prepared to find their value inferior to that of the true coals of Scotland or England, or of coals belonging to the Carboniferous system, or to the other systems older than the Tertiary. I have been asked whether there is no chance of the *discovery of true coal in connection with any of the numerous Otago limestones*. This point I am not in a position to determine; it is an interesting problem for solution by your Provincial geologist. Should what is called by geologists the “Mountain Limestone” be found in Otago, true coal may reasonably be looked for. But the limestones I have met with, so far as I can at present venture an opinion, seem of a more recent age, and are not of a kind usually associated with coal.

Lignites you possess in abundance: for they are scattered in beds of greater or less extent very generally over the province. They occur in, and they are probably co-extensive with, the older tertiary auriferous “Drifts,” which constitute one of the most marked features of Otago geology. One of the largest workings in the Dunedin district, perhaps in Otago, may be seen at Saddlehill, on Mr Jeffrey’s property of Saddlehill Park, on the flank of the hill looking towards the Taieri Plain. Lignites crop out at various points on the slopes or base of this hill, or in its immediate

* This impression is so far borne out by the analyses, since my return home, by Dr Murray Thomson of Edinburgh, of a series of the Otago lignites. His analyses embraced 8 series of samples, including Saddlehill, Clutha, Abbott’s Creek, and M’Coll’s Creek, lignites. Among the results is the following—that they are comparatively poor both in *oil* and *gas*:—the highest proportion of *oil* per ton being 17 gallons (Saddlehill), and of *gas* 3931 cubic feet (M’Coll’s Creek). I reserve details for future and separate publication.

neighbourhood; for instance, between Saddlehill and Scrogg's Hill on the Government Coal Reserve; in the gully in which M'Coll's and Taylor's Stations are situated, on the seaward aspect of the hill; on the farm of Fairfield, and in the adjoining Abbott's Creek. They are being worked also in the hills between the Tokomairiro Plain and the sea, on the slope of the range which looks towards the plain; and on the coast near the mouth of the Clutha. It is proposed further to work them on the Gold Fields—at Waitahuna and Wetherstone's Flats. My remarks must, I think, have sufficiently implied that I would recommend caution in any speculations as to working these Lignites—especially under the impression that they are true *Coals*. To be more specific, I would point to the circumstances under which the Clutha Coal-field is now being worked, and the Waitahuna and Wetherstone's Fields are proposed to be worked. In regard to the former I have to express a doubt whether the considerable expenditure of capital indicated by the railway and other appliances will be followed by adequate returns—especially seeing that lignite, apparently of the same kind and quality, in as great, perhaps greater, abundance, *is to be found within six to eight miles of Dunedin*, in what may be called the *Saddlehill Lignite Basin*. In regard to the lignite beds of Tuapeka Gold-field, I have to remark upon the inexpediency of “getting up” a company and proceeding to work a “coal-field” that has not been surveyed by competent persons. While on the gold-fields lately, I was told, on what I cannot but consider the best authority, that a company has been, or is being, formed at the diggings, for the purpose of working the lignite of Waitahuna and Wetherstone's Flats. Enormous profits are expected from its sale among the diggers. The whereabouts of the coal at Wetherstone's, at all events, and other matters therewith connected, seem to be kept a profound secret; the consequence whereof to me was, that though I searched diligently in the locality to which rumour pointed as its site, I failed in finding it. I was informed, further, that the extent of the field or seam is unknown; its value a matter of conjecture:—that neither locality has been visited by a geologist, nor reported upon by any competent authority. So far as I could learn from investigation on the spot, nobody seems to know anything precise regarding this so-called coal, which, as is the case with all latest discoveries, is said to be the finest coal yet found in New Zealand, but which, I fear, will prove neither better nor worse than the lignite of Saddlehill, the Clutha, and many other localities; and yet apparently steps are being taken to work this “coal.” This is surely a kind of speculation as unsafe as it is unsound. I am far from saying it will *necessarily* prove unsuccessful or unfortunate; but I do say it deserves to be,

if resting on no better basis than that described to me by the local authorities.

Museum of Local Natural History.

Having indicated, by a few illustrations, what fruits may be expected from a judicious cultivation or promotion of the study of the Natural Sciences,—how and to what extent these sciences, if rightly applied, may aid materially in the advancement of the State,—let me consider, in the second place, the most legitimate means—the best, the cheapest, and easiest methods of rendering these sciences available to the citizens at large, as well as of applying them to the specific requirements of Government or of individual settlers. The most obvious and easy means of recognising the place and power of natural history in your province, and of developing its applications to practical life, is the establishment of a *Museum of Local or Provincial Natural History*, or a collection of the products of this province, with such products only of other countries as will enable you to understand and appreciate the true position and value of the economical resources of your own province. Let such a Museum be essentially a collection of the rocks, minerals, plants, and animals of *Otago*;^{*} and let it possess an attached *Library*, containing such works on the natural history of Otago or of New Zealand, or such general works on natural history, as will enable the student duly to learn the lessons which the specimens displayed in the Museum-cases are ready to teach him. Of such a library there is great want, and of such works there is an astonishing dearth. I have not heard, for instance, of any person or corporation in the province possessing a copy of Dr Hooker's work on the "Flora of New Zealand," the most complete work on the subject yet published. I am told that the expense of such a work prevents its purchase by individuals; and this perhaps is a valid excuse for *individuals*. But, as a work of reference, it ought undoubtedly to have a place in some of your public libraries. Moreover, I know that the first British authorities in Botany—Sir William Hooker, and his equally distinguished son, Dr Joseph Hooker,—of Kew—are extremely desirous of issuing *cheap Colonial Botanical Manuals*, were there any demand for such works. Show that you desire

* I was, while in *Otago*, referred for the only good collections of *Otago* rocks, fossils, and minerals, to two private geologists at *Wellington*, and of *Otago* plants to a lady at *Sydney*; and I had the opportunity of examining a better suite of illustrations of *New Zealand* geology and mineralogy in *Sydney* (in the magnificent collection of the Rev. W. B. Clarke, the Government geologist of New South Wales) than in New Zealand itself! This is a state of things discreditable in the extreme to New Zealand generally, as well as to its respective provinces!

and require such works, and a supply would speedily meet the demand: offer the necessary funds for publication, and England will forthwith send you a Manual, which cannot fail to be useful to all who are connected with land—and who is not?—among your settlers. A Museum may appear to many of you a formidable undertaking, and one that may well be delayed, while so many institutions of more immediate importance must be established. The idea of a Museum may be associated in your minds with conceptions of a large, handsome, imposing structure, a well-paid and full staff of consequential officials, and endless glass cases; it will thus appear *necessarily most expensive*. But, in a young colony like this, it need be nothing of the sort—at least in *nucleo*; and all I would at present recommend is the formation of a *nucleus*—a step which may be taken with little trouble, and at little cost. The first desideratum is perhaps a few earnest men to take action in the matter—to organise a committee, to hold public meetings, to agitate by means of the press. Surely some of the energy which has lately been, and is now being, displayed by the office-bearers of the “Young Men’s Christian Association,” might be spared in this direction. I think I can venture to assure them that many would flock to their standard were it only raised. I have met many settlers, of every class and in every part of the province I have visited, most favourable to the establishment of a Provincial Museum, and who, I feel assured, would aid it by every means in their power—by subscriptions, if necessary—had they only a guarantee that such an institution would be properly managed, by which I mean, principally, had it only a competent Head as Director or Curator. The feeling is very general (and I confess I think the feeling a just one), that a Provincial Museum should be established and maintained essentially by Government. But this is no excuse for inaction. It is not at all likely that Government will take the initiative in a matter of this kind, when it has so many more pressing and serious wants to relieve. Nor, it is possible, might Government, at any more favourable time, be disposed to patronise such an undertaking, unless under the *vis a tergo* of strong public feeling; and, lastly, Government may repudiate all connection with such an establishment, and refer it to the individual or collective exertions of the colonists themselves. On what plea they might do so I know not. Education is the care of the State, and a Museum of this kind is just as much an *educational establishment* as any of your provincial schools. If it be not so, it ought to be so, and the fault must lie with its originators and managers. I can show, I think, presently, that a Museum may be made an educational establishment of a very high and important kind—one allied in character to our home universities. It seems to me desirable that the colonists should

actively take up the matter themselves—aided by Government if possible, without Government assistance if necessary. Let a few friends of the movement convene a meeting, and pass a resolution that the establishment of a Provincial Museum is desirable, and I doubt not for a moment the practical heads and active hands of the colonists will soon find means of carrying their views into effect. All that is at first wanted is a room for storage; by and by another room fitted up with presses, shelves and drawers would be added. I am told that there are buildings in Dunedin already existing which might easily afford the accommodation requisite; and I am given to understand, further, that such an appropriation or application of their space, or at least a portion thereof, would be quite consistent with the objects for which such buildings were erected. I refer to such a building as the *Athenæum*, which I think could not be devoted to a more legitimate use than that of a Provincial Museum, and which is at present, I am told, occupied as a merchant's warehouse or store-place. What arrangement should be made with the proprietors of such a building, I leave it to you to decide. My acquaintance with its history, and my local knowledge, are such that I can venture no suggestions on this head.

I look upon a competent *Curator* as the essential feature of a Museum, and, in your case, as its most expensive feature. Without a curator to organize its machinery, and to keep that machinery smoothly in regular and constant action, I have no great faith in the stability or permanent usefulness of a Provincial Museum. Without such an officer, I do not see how you can satisfactorily start it. You must have some competent authority to name and to classify specimens—some enthusiast, with the necessary leisure and interest in his work to encourage the collection of objects of natural history, and the study of such sciences as geology, mineralogy, botany, and zoology. Unless you have already in the colony some naturalist, quite competent, in the first place, and quite willing, in the second, to give his whole services, either gratuitously or for suitable remuneration, as curator of the nascent Museum, you must—if you wish your Museum to hold a real position of usefulness—procure a suitable person *from home*. However well qualified your colonial naturalists may be, I have met with nobody who could sacrifice the necessary time for so worthy an end; all are too much engrossed with their own private affairs. I believe a properly selected head of your Museum would be an immense acquisition to your province. He would, in the first place, be at his post to receive specimens sent up from the country, and I feel certain he would soon succeed in inducing settlers in all parts of the colony *to collect*. He would name and arrange these specimens in

the Museum. He would be ready to receive country settlers during their visits to town, and to instruct them practically how and what to collect; how to preserve specimens; to set them in the way of acquiring a thorough knowledge of the Natural Sciences, or of such of them as they might have a bias towards, or find it more particularly their interest to study. He would be at hand to solve difficulties, answer inquiries, and afford encouragement. He would be librarian as well as curator, and introduce students to the judicious use of the works in Natural History placed under his charge. In due time he might become a *Collector* as well as a *Curator*. His first duty would be to organize the Museum,—to provide or see provided, the requisite rooms, fittings, apparatus and staff. Thereafter, he might take occasional excursions through the province, making observations and collections in all departments of Natural History, or in special departments, sending or bringing back his collections to the Museum, which would always form his head-quarters. Such excursions would be of great importance, not only to himself, but to the promotion of scientific interests in the province. He would thus not only become thoroughly acquainted with the natural resources of the province, but he would personally come in contact with all classes of settlers, in whom he would not fail—in many cases at least—to inspire a certain love of, or respect for, Natural History, or an interest in the objects for which the Provincial Museum was founded, and for which he was exploring the country. The result would, in all probability, be, that in every tour or excursion he would raise up fresh friends of the Museum—friends who would aid it by their subscriptions, or their contributions of specimens—probably both. Another great advantage of such excursionizing would be, that he might fulfil the duties, or occupy the position, of a *Surveying Naturalist*, and that, in course of time, by such means, a thorough *Natural History Survey* of the province might be secured. Were the summer months, for example, devoted to such excursions, an assistant being left to manage the routine of Museum business, important results might in a few years be obtained. There is yet, however, other work for him, whereby you might still further “get value for your money.” In addition to being curator of, and collector for, the Museum, as well as Provincial Naturalist, he might be most useful as a *Lecturer* and *teacher*. He might give lectures, or institute classes, for different sections of the community, at different hours of the day, or at different seasons of the year, in connection with the Museum. With this view, a lecture room would fall to be added to the accommodation proper of the Museum. By the aid of the diagrams now so common and so cheap, and with all the resources of the Museum shelves at his command, science might

in his hands be made popular and most attractive. Such courses of instruction would, or should, be attended by, or at least open to, the *ladies* of the province; and, if they do not differ remarkably from their fair sisters at home, the Provincial naturalist would not find *them* his least anxious caterers, his least zealous supporters. Natural History has become a common and favourite feminine study at home—with what success the ferneries, the albums of sea-weeds, the baskets of shells, the marine aquavivaria of our ladies' fancy bazaars sufficiently testify. But he might disseminate his knowledge much more widely. While on his tours, he might lecture in district schoolhouses and churches, a boon which I venture to predict would be duly appreciated in country districts. I am assured on every hand, both in town and country, that lecturers are "at a premium," to use a commercial phrase: they are scarce, sometimes "not to be had," (to which circumstance, by the way, I must not forget, I probably owe my presence here this evening), and any addition to the lecturing staff of the province would be most acceptable. The newspapers are also open to such an officer; with a daily sheet at his command, how rapidly could he disseminate information—how easily announce the arrivals of specimens, intimate his excursions or lectures, and issue his suggestions. The Press, by and by, will be open to him in a more substantial and permanent form. You will doubtless, in due course, have your publishing houses in Dunedin, whereby he may issue his pamphlets, or his volumes, on subjects bearing on Provincial Natural History. It will naturally occur to some of you, as an objection to the appointment of such an officer, that such appointment would entail a very heavy expense. This, however, is not necessarily the case; though, even if it were, I think you would find the outlay well invested. At home there are many young men, enthusiasts in the pursuit of Natural History, who would be delighted with the privilege of occupying so novel and so rich a field, with so brilliant a prospect of gathering their laurels—of making substantial additions to science—with so promising a sphere of usefulness. Such youths are to be found as assistant-curators in our public Museums, our University and National Museums, and the experience they have there acquired would render them most useful public officers here. Some of this class, I should think, would be glad to come to terms. They would probably look more to their opportunities as men of science, than to mere salary or emoluments, though indubitably Naturalists *must live* as well as other people, and on something more substantial than enthusiasm. In addition to a guaranteed salary, which, considering his real usefulness and scientific status, should, in my opinion, be handsome, such an officer might be permitted by his employers, be they the Govern-

ment, the public, or the members of a private association, to add to his emoluments by the fees of lectures and classes, or of such other offices or duties as he could undertake without prejudice to the objects for which he was brought from home. I see no difficulty in securing a suitable person on suitable terms, which must, of course, be the subject of private arrangement. I am not sanguine enough to suppose that a Provincial Museum will ever become of the same real use to the present, as to the rising, generation. To the latter, I think it might be made one of your most important educational establishments, and therefore it is that I should like to see it systematically organized, thoroughly equipped, and firmly rooted as a State institution of recognized value; with a view to all which I will only be too happy if I can in any way forward its interests at home.

Geological Survey of Otago.

The fact that the Government has recently appointed a *Provincial Geologist*, who is expected shortly to enter upon his duties here, is without prejudice in any way to the remarks I have just made under the head of Museum. I am quite aware of the circumstance of the appointment having been made; but so far from such appointment interfering in any way with the schemes I have proposed, it appears to me most opportune, as affording a means whereby you may at once commence your Museum, organize its machinery, and carry it on, till you can procure a special curator. The assistance of so experienced a naturalist as Dr Hector, who has distinguished himself by his labours in the Palliser expedition across the Rocky Mountains of North America some years ago, could not fail to be valuable. I cannot refrain from stating here that I think it reflects high credit on Otago that she is the first province in New Zealand to have made arrangements for a systematic geological survey, a survey which should imply the expenditure, in my opinion, of at least £10,000; that is, including the cost of the proper publication of reports, maps, and drawings, which publication can only be carried out in Britain, and at necessarily great expense. And it seems to me doubly creditable that the suggestion regarding such a survey was made, and the arrangements carried out, considerably prior to the discovery of the gold fields of Tuapeka and Waitahuna; so that I presume it was from a firm faith in the usefulness of geological science in a practical sense that the Provincial Government passed its vote for this survey. I am glad to find that other provinces of New Zealand are following in your wake in this respect, and I doubt not *all* will sooner or later be encouraged by the results of *your* Geological Survey to do so. I know not how far the suggestion may meet with the approval

of your Government or Dr Hector; but I hope neither of them will be offended by the simple expression of individual opinion. It appears to me that Dr Hector's presence might legitimately be taken advantage of in establishing the nucleus of the mineralogical and geological sections of the Provincial Museum, as well as in the dissemination of a knowledge of local geology and mineralogy by the medium of lectures or classes. For such purposes advantage might be taken of the completion of the survey, of the winter season, or of periods of inclement weather, when the survey may be temporarily suspended. A properly named and classified collection, first, of the rocks and minerals of Dunedin, and by and by of those of other parts of the province, might be made. Whenever the funds would admit, I would strongly recommend the purchase of coloured geological diagrams, models of crystals, and other scientific educational apparatus, now easily to be had, as well as a series of selected named specimens—as standards—of rocks and minerals similar to those of Otago, and which throw light on the relations and uses of the latter; specimens, for instance, from the Trap districts of Scotland, the volcanic regions of Iceland or Italy, the Chalk districts of England, or the Tertiary formations of Germany and France. These are procurable, at a moderate expense, at such establishments as Professor Tennant's, in London; or Krantz and Co., of Bonn and Berlin. With the aid of such specimens, diagrams, and apparatus, as illustrations, and by means of field excursions round Dunedin, your Provincial geologist might teach practically, in a most attractive way, details of the sciences of geology and mineralogy, or the rudiments thereof, according to circumstances. Government would surely grant every facility in the way of accommodation and assistance for so desirable an end. I am told Dr Hector is daily expected. I am not at all aware whether any or what preparations have been made here for the prosecution of his survey: but it appears to me that the way may be so far paved for him; his labours so far facilitated and aided; his objects co-operated in. There is not one of you, probably, who may not in some way, however humble, promote Provincial geology by co-operating in the efforts of the Provincial geologist. You are at considerable expense in providing the staff and requisites for a geological survey; your being so shows the value you place upon the possession of the information such a survey is expected to collect or educe. It is surely your interest to get the best, the largest return for your outlay—to make the most of your engagement. You will best consult your own interests then by doing all that in you lies to further the aims and objects of Dr Hector. You may do so in various ways, but on one only of these will I touch. I would suggest that so soon as Dr Hector arrives, Government should insert in all the local newspapers an

intimation of his arrival, and thereafter announce, from time to time, the localities he is about to visit, calling upon settlers of every kind to note all peculiarities of rocks in their neighbourhood, and to collect specimens of rocks and minerals—all which should be produced in due time to Dr Hector. This would probably direct his attention to places and circumstances that might otherwise escape him. I have myself derived great benefit from collectors of “curiosities,” which generally include a miscellany of rocks, minerals, fossils, shells, eggs, insects, and so forth. I have frequently seen specimens in such collections which at once arrested my attention. Their owners or collectors knew perhaps little or nothing of their value, but they could tell where they picked them up, and could lead me to the spot. In such a way some of the most interesting geological phenomena I have seen have come under my notice. These so-called “curiosities” were casually collected as mementoes, perhaps, of visits to localities beyond the beaten track of travellers, as playthings for children, or as mantelpiece ornaments. Were, however, the attention of the same collectors directed to the fact that such specimens might lead the Provincial geologist to discoveries, if not practically important, at least scientifically interesting, with this higher motive, and a more intelligent conception of the bearings or value of such specimens on the promotion of scientific research, they would become more careful observers, more diligent collectors, and ultimately many of them efficient co-operators, and learned geologists. Dr Hector will probably necessarily be engaged for some time in Dunedin preparing the groundwork of his survey, and Government would therefore, on or after his arrival, have ample time—especially as it now has at its command the inestimable advantages of a daily newspaper—to communicate with the settlers in the most remote parts of the province, and so set them on the alert as observers and collectors in Natural History. It is evident that the more the Provincial geologist sees and hears of the geology of your province—the greater the number of specimens presented to his notice—the more varied and abundant the information supplied,—the more valuable will be his survey report, and the better pleased you will be with the expenditure of your money. Let me hope, then, that, in the light of your own interests as well as in those of science, you will accord your heartiest assistance to the able naturalist you have been fortunate enough to secure as Provincial geologist.

Botanic Garden.

A second great desideratum in Dunedin is a *Botanic Garden*, whether regarded in a purely scientific light, or in that of a public

recreation ground, a promenade and place of resort.* At present I am not aware there is anything of the kind, while there appears no lack of suitable sites in the possession of the Government. I have found among the settlers throughout the province a strong feeling in favour of the establishment of a Botanic Garden; and so long as you possess men so admirably qualified by experience and tastes to act as committee men in promoting such an undertaking as Mr Matthews of Dunedin, Mr Martin of Saddlehill, Mr Bower of Anderson's Bay, and Mr Buchanan of the North-east Valley, you need have no hesitation in taking the initiative. Many of the remarks I have made under the head "Museum," apply equally to the Botanic Garden. It may appear to you a more extensive and expensive undertaking than even the Museum; visions of magnificent hothouses, greenhouses, and conservatories, of ornamental sheets of water and fountains, of terraces and parterres, will probably appear to those of my audience who have vivid imaginations. But none of these are necessary *to begin with*; they will all be added *ultimately*, I doubt not. A small piece of ground and a small staff would suffice at its first start. It is most desirable that the Botanic Garden should have a separate and competent Head as Director; but, should the expense of such an arrangement be found an insurmountable obstacle, the Curator of your Museum might act as director for a time. Indeed, should a more convenient building not offer itself, the Botanic Garden would form an excellent and appropriate site for a new Museum building. The latter would be rendered all the more attractive by the luxuriant foliage of, and the beautiful views from, the former. The first aim of such a garden should be to collect together, name, and classify, *specimens of all the plants of Otago*, so that a glance might give the stranger or the mere townsman a good idea of the general vegetation of the province. By and by, the collection might be made to include, in proportion as the garden space was extended, and the garden finances permitted, the plants of the adjacent provinces, of the North Island and Stewart's Island, of Tasmania and Australia, of the Chatham and other neighbouring islands. Thereafter, European plants might be added, if it were

* The experience and example of the Sydney Botanic Garden may be useful. It occupies one of the finest sites about Sydney, and is most tastefully laid out,—less, however, as a garden arranged purely for the purposes of science than as pleasure-grounds for the purposes of public recreation. Its attractions include an orchestra for the regimental band, which plays regularly on certain days of the week,—on which "band days" the garden becomes the most fashionable promenade in Sydney; and an aviary, with ponds for aquatic birds. But the scientific is not forgotten, for the garden possesses an excellent Botanical Library and Museum, as well as a Lecture-room, where the excellent Director, Mr Moore, gives public courses of Lectures on Botany. Amidst such environments, it would be surprising did such lectures fail to prove attractive to a considerable section at least of the general public.

deemed advisable; but the garden ought to be *essentially representative and local*—a collection of *Otago plants, Otago products*. Secondly, it might become an excellent *Experimental Garden*, a place where, appropriately, properly conducted experiments might be instituted as to what foreign plants are suitable for growth in Otago; what will flourish in its climate; what might be acclimatised or naturalised, so as to become useful to the settler for his shrubberies or gardens, his plantations or hedges; what trees may be made to supply the place of the monarchs of the virgin forests, which are fast disappearing under the axe and fire of the settler—under the insatiable requirements of advancing civilisation. Thirdly, the *Exchange of seeds* would probably form an important feature in the usefulness of your Botanic Garden. There are many of your native shrubs, such as the *Eurebias* and *Fuchsias*, which would make beautiful and acceptable additions to our shrubberies and gardens at home; and I am sure that our nurserymen and seedsmen in Britain would gladly, in exchange for the seeds of such of your shrubs as seemed suitable for British cultivation, send to your garden the seeds of any plants usually cultivated in their gardens or forcing-houses. In connection with such exchange of seeds would be the intercommunication of information regarding the plants represented by the seeds—information mutually important, mutually desirable. Many of your Provincial gardens—your settlers' gardens, I mean—are quite Botanic gardens in miniature: they are carrying out on the small scale the aims which it should be the business of the Botanic Garden to carry out on a larger one. In the gardens of some individual settlers you may find excellent collections of the more interesting shrubs of Otago, of Tasmania, and Australia—shrubs which are being naturalized; and of British or other plants, the seeds whereof have been received in exchange for those of Otago plants. Such gardens are those of Mr Matthews, of Dunedin; Mr Shaw of Finegand, on the Clutha; and the Rev. Mr Will of the Taeri. These are not solitary instances; for the wants, which a Botanic garden would supply, are extensively felt.

University of New Zealand.

Not less important, as a means of promoting science in your province, than either a Museum or Botanic Garden, at the same time not as superseding these, would be the establishment of a University, or at all events at first the nucleus thereof. Such an institution is desirable on many other and more important grounds. A University in Dunedin might become not only the Provincial University, or the University of the Middle Island, but the *University of New Zealand*. I believe that New

Zealand will gradually, more and more than at present, be selected as the residence of our successful Australians, and East Indians. Its climate will be in request as one better suited to the physical training of youth than the climates of more tropical countries. Did good educational establishments, of the higher kinds especially, exist in the Middle Island of New Zealand, this would probably prove a great attraction, from the excellent opportunities offered for the education of youth, to many who might not otherwise have thought of emigrating, or of sending their sons or families hither. For many reasons, it appears to me the Middle Island will be preferred to the north as a place of residence, and a place of education. And further, it seems to me that the first of the New Zealand Provinces, which will establish a University, will, *ceteris paribus*, attract towards itself the classes of persons above referred to. I am glad to find the same view has occurred to the late Dr Arthur Thomson, in his "Story of New Zealand," the most recent and best work on New Zealand, with which I am acquainted. His remarks are so apposite and brief, that I make no apology here for introducing them. "*A University of the highest order is urgently required in New Zealand.* Such an establishment would draw within its walls large numbers of the Australian aristocracy, as Anglo-Saxons born and reared on that continent are occasionally destitute of the bodily energy requisite for the full development of the mind. Two generations in Australia change the children of the broad-shouldered emigrants into a lithe race, more nervous than muscular. 'Sydney corn-stalks,' as the youths of that city are denominated, are no match in intellect against men brought up in colder countries. For this reason, Australian settlers will strive to give their children a few years' residence in climates more invigorating than that in which they were born; and it is already discovered that the best period for this is on the approach of maturity, when youth is rising into manhood, and the mind is developing itself for the future battle of life. *Whichever province in New Zealand, therefore, can found a University, where youth can be taught as the youth of England are taught, will acquire a name and an influence in the Southern hemisphere, not to be measured by money or the figures of the statist.*" [Vol. ii., p. 230.] So far, at least, as the study of Natural History is concerned, I can scarcely conceive a more fitting site for an "*Academe*" than Dunedin. In the midst of magnificent scenery, with a rich and varied geological and botanical field before him, the student's natural advantages are great; and these advantages would be enhanced, had he access to Museums and Botanic Gardens, Libraries and Class-rooms, as already described. If a Museum or Botanic Garden appear to you necessarily expensive, I fear a

University will appear much more so, if you think of it as a massive pile, richly ornamented, its niches containing statues of the great and good, with endless lecture-rooms, a commodious library, and an imposing Senate Hall, two or three dozen learned Professors, and a venerable Principal. It is, however, far from necessary—it is not, perhaps, desirable—that you should at once establish a University complete in all its parts.* All I would recommend, so far as Natural History is concerned, is the appointment of two or three professors, who would be easily accommodated, and who might be most useful Government officers, independent altogether of their “chairs.” No separate buildings would be necessary at first. I would house the Professors in the Museum, though this would imply your making this building commodious. Your Provincial Geologist might be *Professor of a certain section of the Natural Sciences*, certainly of *Geology and Mineralogy*, with their economical applications. He might act as Government referee on all questions relating to mining and quarrying in their scientific aspects. The Director of your Botanic Garden might be your *Professor of Botany*, and perhaps also of *Zoology*, with their economical applications. He might also hold office as *Conservator of Forests*, or have a seat at a *Board of Woods and Forests* as professional referee. He would be a useful authority in all questions relating to the acclimatisation of plants or animals, agriculture and arboriculture,

* Let me indicate the University of *Sydney*, less as a model for imitation, than as a beacon of warning against dangers liable to be incurred. I have visited and greatly admired it *as a building*. But I think it has aimed at too much in the form of building, which is both too extensive and expensive for the requirements of the age and of the colony. The consequence of this error is, *inter alia*, that, contrasted with the size of the edifice, there is a miserable paucity of students; and throughout the colony there seems to exist a feeling of insecurity or want of confidence in the solidity or stability of this the Provincial University of New South Wales. While the building is on too large and expensive a scale for present requirements, the Professorial staff seems inadequate,—especially in so far as the Natural Sciences can be thereby represented. There is only *one* Professor of these sciences, the particular science taught being *Chemistry*. In a country which owes so much of its prosperity to its gold, its coal, its sandstone, there is *no Professor of Geology or Mineralogy*,—while New South Wales possesses at least one local Geologist eminently worthy of such a chair, the Rev. W. B. Clarke of Sydney, whose distinguished labours in connection with the discovery and development of the Australian gold-fields, I am happy to see, have recently been rewarded by a handsome Government grant or honorarium. Nor is there any Medical School in connection with the University, though there is a large general Hospital in Sydney, as well as large Lunatic Asylums at Tarban Creek and Parramatta in its vicinity. And yet all of these might exist *at a moderate expense, and without a separate University building at all!* It would have been desirable had the large expenditure of the Sydney University taken first the direction of the *essential* constituents of an efficient *Academe*,—*a staff of Teachers of celebrity*: the walls or buildings would gradually have followed as they were required and could be afforded.

in their scientific aspects. Another Professor could hardly be dispensed with; indeed his usefulness is, perhaps, more evident than in the case of the other two. I refer to a *Professor of Chemistry*, who might also be *Government Analyst and Assayer*. At present, I believe you send your gold for assay to Sydney; and you are dependent entirely on Australia or Britain for chemical reports on the percentage of iron in your iron sands or ochres, sulphur in your sulphur muds, lime in your limestones, gas or oil in your lignites. Would it not save time and trouble, delay and suspense, as well as expense, to have your analyst always at hand—always at your service. He would be ready to act as agricultural chemist, making analyses of soils for settlers. He would be a valuable referee in medico-legal cases, in judicial examinations in cases of poisoning for instance, and in similar cases where the chemical, would necessarily be the chief, evidence. He would act as a detector of adulterations in your foods and drinks—adulterations which are generally rife in such a state of society as exists in Dunedin at present. Even as a reporter on the quality of the water-supply proposed for your towns, he might be of signal service, especially in regard to indicating the proper materials for conveyance and storage. Such Professors might give systematic instruction in their respective sciences to all who desired to take advantage thereof, as well as more general and popular courses of lectures to the public at large. The contents of the Museum would afford abundance of suitable illustrations. All three Professors might, if necessary, occupy the same lecture room at different hours, or at different seasons, though there is no doubt separate and ample accommodation would be desirable. The Professor of Chemistry would, in addition, require a small Laboratory, the cost whereof would reside chiefly in its fittings, which, however, may be had at a very moderate outlay. Let us hope that ere many years elapse, “New Edinburgh” may possess in the Southern Hemisphere a University rivalling that of “Old Edinburgh” in the Northern; and if it does so, I will venture to predict it will become *the* University, not only of New Zealand, but of this (Southern) Hemisphere!

Teaching of Natural Science in Schools.

But, pending the establishment of a University, which must be gradual in its growth, there seems no reason why the existing educational machinery of the province should not be rendered available for bestowing upon the rising generation scientific tastes, if not acquirements. I would commend to the favourable consideration of your Education Board the propriety of introducing the teaching of at least the *rudiments* of Natural Science,—of such

sciences, especially, as Physiology, Zoology, Geology, and Botany, into your district schools, and especially into your High Schools. The means of doing so are now ample. Books and diagrams, named specimens, and working models, may be purchased at extremely moderate rates from educational publishers. What is called "Object-teaching"—the teaching of science by means of actual specimens—is now common in our most elementary schools at home. This method of teaching has the immense advantage that facts are indelibly graven on the mind, without any appreciable effort of thought or memory, the observative more than the reflective faculties being thus educated in a way most attractive and interesting to the pupil.

Natural History Society.

Much might be done mutually to diffuse a taste for natural history studies, by the establishment or formation of a *Natural History Society*. Meetings might be held periodically for the reading of papers relating to local natural history; specimens of rocks and minerals, plants, insects, shells, &c., might be exhibited; excursions might be planned; encouragement and assistance given by the more to the less experienced. Such societies are abundant at home, and are most serviceable, especially to youth. The "Natural History Society of Dunedin," or of Otago, might, in the first instance, be an offshoot from the "Young Men's Christian Association," and would probably, ere long, have an independent existence, and a distinct sphere of usefulness. The establishment of a Natural History Museum, Botanic Garden, and University, and the introduction of science-teaching in schools, will probably, each and all of them, give an impetus to the formation of societies of this kind; and this is an additional reason why no time should be lost in taking steps towards the carrying out these most desirable schemes. There is no lack of settlers with the requisite tastes and enthusiasm to form a solid nucleus, a good working committee; nor is there wanting the readiness to become members of a Natural History Society, were it only established. But the great difficulty here, as in all the schemes I have propounded, is *the start*; and here is another instance, added to the many that can be cited, of the value of the presence of competent Naturalists among you,—men who have their whole time to devote to the prosecution and promotion of Natural Science, whose interest it is pecuniarily to use their best efforts for its progress,—whose bias and tastes, whose habits and experience all tend in this direction, and who would be the soul and life of such a society—of any association, which might have for its object or aim the study or applications of Natural Science.

Example of Victoria in its Encouragement of Natural History.

In connection with the schemes I have above advocated, I would ask you to look to the example set you by your near neighbour and fair sister Victoria. Consider what Melbourne has accomplished for the promotion of science during the short ten years of her existence. Visit her magnificent Botanic Gardens—her excellent Museums of Natural History, Geology, Mining, Agriculture, &c.—her University and her Royal Society—and see whether these do not afford proof of an enlightened recognition of the value of the Natural Sciences as a power in colonisation. What Melbourne has achieved, Otago may, with similar energy, aspire to accomplish. I am sanguine as to the future of your province. I believe that, independently altogether of the gold-fields, it possesses many elements of future greatness and distinction; that it has boundless resources, which it will take many years fully to develop and appreciate; that, prior to the discoveries of Gabriel Read, Otago was progressing “slowly but surely,” silently and unostentatiously, but substantially, in all that constitutes a healthy colonisation. But I believe, further, that though this satisfactory progress would have continued had there been no gold discovery in your province, one result of such discovery will be to render the said progress greatly more rapid. You will find the colony in one year in a position it would probably not have reached in ten or perhaps twenty. Much depends—though everything does not depend—on the *permanency* of your Gold Mining, the extent and productiveness of your gold-fields. To take the worst view of the question,—should the gold-fields fail, should they prove of very limited extent, there would probably result an immediate great commercial distress—a distress, however, that would probably affect your speculative Victorian brethren more than yourselves. Your country would remain much in the state in which the discovery of the gold-fields found it, with the exception that your settlers would have the advantages of additional population, additional roads and bridges, and other desirable results of the temporary influx of population. There is no reason, however, for supposing the gold-fields of Otago to be of very local character, or of very limited extent; while experience is daily showing they are abundantly productive. To what extent they will compete in the long-run with the Victorian gold-fields remains to be seen. That they are at present competing successfully therewith is a fact that can no longer be doubted. I have repeatedly been assured by gold-seekers—many of them of Californian as well as Australian experience—that the escort returns of no single gold-field in other countries, within the same space of time, have ever equalled those of Tuapeka, and that Gabriel’s Gully has proved,

in proportion to its size, the richest gold-field ever discovered or worked in any part of the world. The present horizon of the colony, therefore, is bright and cloudless. Your land, your flocks and herds, are rising rapidly in value. Dunedin is being metamorphosed, at a Victorian rate of progress, from a village into a city. The stream of population is at the flood. This population brings with it large numbers of the educated classes of society; and these classes, let me hope, will not be long in experiencing the want, and demanding the supply, of many, if not all, of the institutions, the establishment whereof I have been recommending.

Conclusion.

Circumstances have compelled me altogether to omit the sections I had originally intended on such subjects as—

I. Under the head of the *Botany of Otago*—

a. The necessity that seems to exist for the careful *Conservation* of your *Forests*, and for the establishment of a *Board of Woods and Forests*.

b. The importance of investigating the nature of the *Tutu Poison*, and of discovering a preventive or remedy therefor.

c. The importance of a comparative study of the *British* (naturalised) and native *Grasses*, as fodder for sheep and cattle on your ranges and runs.

d. The desirability of experiment on the *Acclimatisation*, or introduction, of such of the *trees or shrubs of Tasmania, Australia, or Europe*, as might be found suitable as a protection or environment to your dwellings, or as a substitute for your Forest trees.

e. The development of the economical appliances of your *Flax fibre*.

f. The economical applications of a number of your commonest weeds; for instance, the Lichens of your rocks, which I have proved by experiment here are capable of yielding good dyes.

II. Under the head of the *Zoology* of Otago*—

a. The *Acclimatisation* of many of our *British fish, birds, and other animals*, viz. :—The introduction of the salmon and trout into your streams and rivers; of the grouse, partridge,

* Our ignorance at home of New Zealand zoology may be happily illustrated, in one of its phases, by the following apostrophe by the author of "The Pleasures of Hope:"—

"On Zealand's hills where *tigers* steal along,
And the dread *Indian* chants a dismal song," &c.

It so happens that the most striking feature of the very meagre *fauna* of New Zealand is the *entire absence of animals dangerous to man*,—a circumstance that goes far to render that country one of the safest of all the British colonies.

capercailzie, ptarmigan, and other of our game birds on your ranges; of our common British insectivorous birds generally.

b. The desirability of the establishment of an *Acclimatisation Society*, similar to those of Melbourne and Sydney, of Paris and London.*

III. Under the head of the *Meteorology of Otago*—

a. The importance of establishing throughout the province a chain of *Meteorological Stations*, in connection with a central *Provincial Observatory at Dunedin*, with a view to the collection of precise data, whereon to base conclusions as to the true character of the *climate of Otago*.

Contributions to Ornithology. By Sir W. JARDINE, Bart. No. V,

Acanthylis sabini (Gray). A specimen of this spine-tailed swift was procured by Captain Sabine (now Major-General Sabine) when upon duty on the west coast of Africa; and the first notice of it as a new species appeared in Griffith's edition of Baron Cuvier's "Animal Kingdom," part xvii., 1828, as *Chætura sabini*, Gray, MSS.—"Bluish black, belly and rump white; Africa, Captain Sabine." The specimen thus referred to is now in the British Museum.

It was afterwards more fully described, and the dimensions given (1831), in Gray's "Zoological Miscellany," under the name of *White-Rumped Chætura*, *Ch. bicolor*. Why the change of name we do not know.

When M. Dutchaillu returned to America from his first expedition in Western Africa, his ornithological collections were described, and a list of all the species was given, by John Cassin in the Proceedings of the Academy of Natural Sciences, Philadelphia, and *Chætura sabini* (Gray), with the synonyms applied to that bird, was printed with the list.

At a later period M. Dutchaillu came to Europe, and his specimens of gorilla and other animals and birds were exhibited in the rooms of the Geographical Society of London. On visiting this collection, we saw that the swift named by Cassin as *Ch. sabini* was not identical with that bird, but had not at that time an opportunity of comparing them. On leaving Europe to resume his explorations in Africa, the remains of his collections were sent to Mr Stevens for disposal, and we then procured a specimen of the bird we had before partially seen.

From the first description in Griffith's "Animal Kingdom," the

* An excellent example has been set by the recent establishment of one in *Auckland*, New Zealand.

mistake was easily made, no measurements being given; but a comparison of the specimens leaves no doubt of their being distinct.

In the "Athenæum" of May 30th, "Dr Sclater pointed out the characters of a species of spine-tailed swift of the genus *Chaetura*, from West Africa, for which he proposed the name of *C. cassinii*." This may be Duchaillu's bird, or any other; but we cannot recognise such notices as descriptions, or as any authority for a name. It has been the practice for many years for gentlemen thus to *announce new names* without anything more, and it has been the source of confusion and great multiplication of synonyms. We now give the characters of the two allied species, describing the old bird from a specimen in the museum of T. C. Eyton, Esq., who procured it from the refuse specimens of the once fine ornithological collection of the Zoological Society.

Acanthylis sabini (Gray), 1828.* Mus. British. T. C. Eyton.

Above, black with blue and violet reflections, rump and up. tail-coverts white, shafts of each feather black, tail-coverts as long as the rectrices without the spine. *Below*, greyish-black; belly, vent and under tail-coverts white, the latter long with narrow black shafts; tarsi and feet slender. Length to end of tail spines, 4; wing, 4.5.

Chaetura sabini (Gray), Cuv. Reg. An., ed. Griff. ii., No. xvii. p. 70. Hartlaub, Syst. Orn. W. Africa, p. 25.

C. bicolor (Gray), Zool. Miscel., p. 7.

Acanthylis bicolor (Strick.), Proc. Zool. Soc., 1844, p. 99.

A. sabini (Gray), Gen. B. Fol. Sp. 8. List B. Brit. Mus., p. 16. Mull. Cab. Journ. Orn., 1855, p. 3.

Pallene leucopygia (Boie), Isis, 1844 (Auct. Hartl.)

P. sabini, Bonp. Consp. Avium, p. 64.

Hab., W. Africa: Sierra Leone (Sabine); Fernando Po (Fraser).

Acanthylis hartlaubi, Jard., June 1863. Mus. Brit. Jard. Philad. (Auct. Hartl.)

Above, black with slight greenish reflection; up. tail-coverts short, those next rump white, forming a narrow band, outer rectrices pale near the shaft. *Below*, chin greyish-white; throat, breast and sides grey; belly, vent and under tail-coverts white; tarsi and feet, strong. Length to end of tail spines, 4.3; wing, 6.

Chaetura sabini (Cassin), Proc. Ac. Nat. Soc. Philad. (without syns.)

Hartlaub (included in synonyms of *C. sabini*), Syst. Ornith. W. Africa, p. 25.

Hab., W. Africa (Auct. Cassin).

* For this date, we take the notice on 16th Number of Griffith's edition of Cuvier,—“The 17th Number of the Animal Kingdom will be published in October 1828.”

NOTE.—*A. hartlaubi* differs from *A. sabini* in the stout short form of the body, long wings, narrow white band on upper tail-coverts, and in the form and strength of feet.

Charadrius virginiacus.—In Dr Hartlaub's *System der Ornithologie*, West Africa, *Charadrius pluvialis*, or common golden plover, only is noted. In a small collection of birds lately sent from Fernando Po by Consul Burton, there is a specimen of *C. virginiacus*. This is not remarkable, being a bird of wide geographical distribution, but it has not yet been noticed as occurring in Western Africa.

PROCEEDINGS OF SOCIETIES.

Royal Society of Edinburgh.

Monday, 2d March 1863.—Principal Sir D. BREWSTER, V.P., in the Chair.

The following Communications were read:—

1. Letter from Sir D. Brewster relative to the specimens of Topaz with Pressure Cavities presented by him to the Museum of the Society.
2. On the Polarization of Rough Surfaces, and of Substances that reflect White or Coloured Light from their Interior. By Sir David Brewster, K.H., F.R.S.
3. On a Clay Deposit with Fossil Arctic Shells, recently observed in the Basin of the Forth. By the Rev. Thomas Brown, F.R.S.E.

The author having stated the circumstances which led to his discovering this bed with its fossils near the harbour at Elie, referred to a drawing of the section, and explained the position and contents of the different strata.

Specimens of the shells were exhibited, as named by Dr Otto Torrell of Lund, who had supplied important information as to their distribution. They are all, without exception, now living in the Arctic Seas. A majority of them are exclusively Arctic. Several are new to the British glacial deposits—viz., *Thracia myopsis*, *Pecten groenlandicus*, *Crenella decussata*, *C. lævigata*,* *Turritella eros*,† and a new *Yoldia* found in Spitzbergen in 80° north lati-

* "Most probably, but much injured."

† "Almost certainly this species, yet cannot be positively asserted."

tude.* It was shown how strongly this evidence goes to prove the former existence of a Boreal or Arctic climate in Scotland.

The shells seem also to indicate some considerable rise in the level of the land. They are deep-water species—some of them very markedly so. Four distinct series of facts appear to show that they have not been washed up and transported, but are lying in the clay-bed where they originally lived. As the deposit is now rather above high-water mark, the fair inference would seem to be that the whole sea-bed of the Firth must have been considerably raised.

Reference was made to the discovery of the glacial beds of the Clyde by Mr Smith of Jordanhill. They had been looked for on the Forth, but without success. Dr Fleming struck the first trace of them at Tyrie, but it was faint, there being only two or three specimens of the shells, and these he was led to think not indigenous. In the Elie clay the same two species occur rather abundantly, along with others, all evidently in the clay-bed where they had lived. The group is so characteristic that there need be no question now as to the occurrence of the true old glacial beds with Arctic shells in the basin of the Forth.

Various reasons were stated for holding that this bed is very closely connected with the boulder clay, being not improbably a sea-formation contemporaneous with some portion of that deposit.

It was shown, that the facts brought to light in this section give us some glimpse into the circumstances under which the period of Arctic cold passed away.

4. On the Remarkable Occurrence of Graphite in Siberia. By Thomas C. Archer, Esq.

Monday, 16th March 1863.—Dr CHRISTISON, V.P.,
in the Chair.

The following Communications were read:—

1. On the Polarization of the Atmosphere. By Sir David Brewster, K.H., F.R.S.
2. Concluding Note on the Star Observations at Elchies.
By Professor C. Piazzzi Smyth.
3. On a new fossil *Ophiuridan*, from Post-pliocene strata of the valley of the Forth. By Professor Allman.

I am indebted to one of our University students, Mr Peter Lawson, for a specimen of a star-fish, which he informed me had been found, along with many others, in a deposit of brick-clay near

* The other species are—*Saxicava rugosa*, large form, *Tellina proxima*, *Astarte compressa*, *Leda truncata*, *L. pygmæa*, *Natica groenlandica*, large form. Fragments also occur which seem to belong to *Cyprina Islandica* and *Mya truncata*.

Dunbar. The interest of this fact was a sufficient inducement to cause me at once to visit the locality where the star-fish was obtained, and where, by the kindness of Mr France, the proprietor of the brick-works, I succeeded in obtaining good specimens of the fossil.

Notwithstanding some very marked characters, which might possibly be regarded as possessing higher than specific value, I prefer referring the star-fish of the Dunbar brick-clay to Müller and Troschel's genus *Ophiolepis*, rather than encumbering the existing nomenclature with a new and doubtful generic name. The species, which is very distinct from every other described member of the genus, may be defined by the following diagnosis:—

Ophiolepis gracilis (mihi), nov. spec.

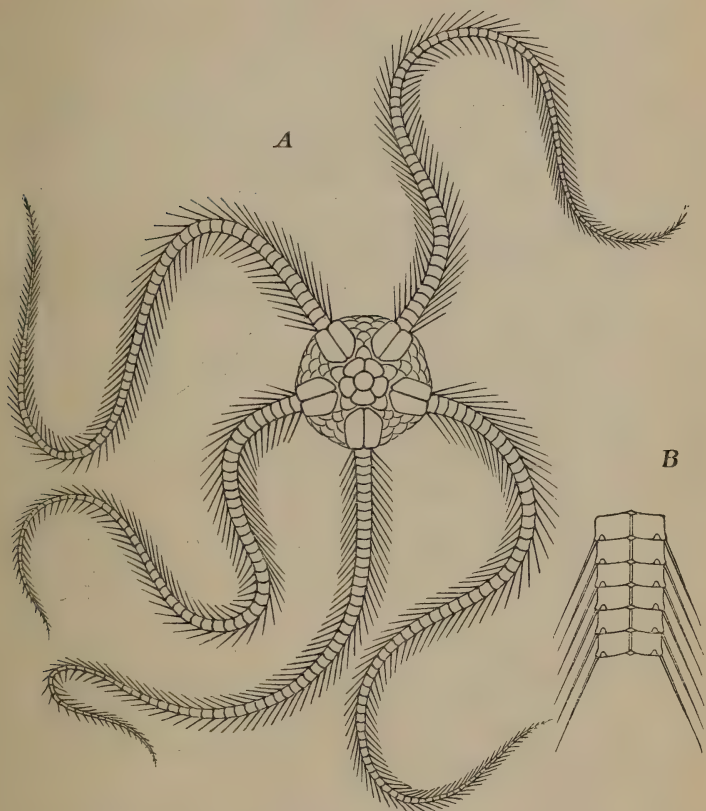
Upper surface of the disc covered with imbricated plates, a single circular plate occupying the centre, and with the radial shields large, and having their opposed edges in contact for their entire length. Dorsal shields of the arms about twice as broad as long near the disc, and thence with their breadth gradually decreasing in proportion to their length, until towards the distal extremity of the arm they become longer than broad; they cover the whole dorsal surface of the arm, and have their adoral and aboral margins transverse and parallel. Ventral shields of the arms very minute, and allowing the lateral shields of one side to meet those of the opposite side in the inferior median line of the arm. Aboral edge of each lateral shield with a notch for the exit of a cirrus. Spines about once and a-half as long as the breadth of the arms. Arms about five times as long as the diameter of the disc, and gradually tapering to a fine point.

The size of the largest specimens obtained is about four inches from tip to tip of the arms.

Fossil in brick-clay of the Post-pliocene age, near Dunbar, Scotland.

One of the most remarkable features in the present species is the rudimental condition of the ventral shields of the arms; these shields being much smaller than in *Ophiolepis ciliata* (Mül. and Trosch.), where they are exceptionally small among the *Ophiuridæ*, and where the lateral shields bear only short papilliform spines instead of the long, highly-developed spines of *O. gracilis*. It was only after having sought in vain for the ventral shields in some dozens of specimens that I succeeded in detecting them in a single instance. In this case they appeared in a view of the internal surface of the ventral wall (fig. B) as very minute rhombic plates lying along the mesial line, where they were interposed between the angles of the lateral shields. It is quite possible that the ventral plates are more fully displayed upon the outer surface of the wall, but in no case did I find this surface sufficiently exposed to enable me to obtain a view of them; while the inner surface, on the contrary, was frequently well exposed by the disappearance in the fossil of the dorsal shields, and of the series of vertebra-like ossicles, which, in the living *Ophiuridæ*, occupies the axis of the

arms. In most of the specimens sufficiently well preserved to afford a view of the ventral walls of the arms, the lateral shields were seen to be slightly separated from one another along the ventral



Ophiolepis gracilis—(A) viewed from the dorsal side, slightly enlarged; (B) ventral wall of one of the arms, still more enlarged, viewed from within; showing the lateral shields slightly separated from one another along the mesial line, where the minute ventral shields are introduced between their angles. The apertures for the exit of the ambulacral cirri are seen near the outer edges of the lateral shields.

suture, leaving here a distinct but narrow fissure, which was not interrupted even by the intervention of the minute ventral plates, which had in almost every case disappeared. In some instances, however, the lateral shields escaped displacement, and the two series were then in contact with one another along the line of suture. The notch for the exit of the cirri or tentacular ambulacra, situated on the aboral edge of every lateral plate, is very distinct, and is completed into an entire aperture by the adoral edge of the plate

next in succession. The spines along the sides of the arms are long and slender; in no case, however, could I satisfy myself that more than a single spine was borne by each lateral shield; but the condition of the specimens does not justify our thus limiting the number of those spines. Neither was I able to discover in the specimens any evidence of scales over the apertures for the cirri.

The deposit in which *Ophiolepis gracilis* occurs is a fine dense tenacious blue clay of Post-pliocene age. It is situated upon the shore of the Firth of Forth, about two miles to the west of Dunbar, and is largely worked for the manufacture of bricks. It lies low; and were it not for an artificial embankment, would be flooded at high tide.

In this deposit, at about five feet from the surface, is a horizontal bed, where the star-fishes are found. They occur in great numbers upon the surface of the bed, which is occasionally separated from the bed above it by a thin parting of fine sand. They are remarkable for their un mutilated condition, lying there with their slender arms, even to the extreme points, in the position which they must have naturally held during life, thus showing an entire absence of that spontaneous dismemberment which is so characteristic of the *Ophiuridæ* when dying under any prolonged irritation, and indicating some sudden cause of deprivation of life, such as we may suppose to result from an irruption of fresh water into the part of the sea inhabited by them.

None of the specimens I obtained, however, were sufficiently well preserved to enable me to make out all their characters as completely as I could have wished, the nature of the clay in which they were imbedded being apparently not suited to the preservation of the more delicate structures. The oral surface of the disc, especially, was in no case retained so perfectly as to allow of the mouth or the disposition of the plates of this part of the animal being observed. It was only in some instances that traces of the spines were visible, and then almost the only indications left were their impressions in the surrounding clay.

It is a curious and interesting fact, that not only did all the specimens found belong to a single species, but that not a vestige of a shell, or of any other organism, could be detected in any part of the clay which I had an opportunity of examining.

Monday, 6th April 1863.—PROFESSOR KELLAND, V.P.,
in the Chair.

The following Communications were read :—

1. Note as to Portions of Lead from the Roof of the Lower Storey of Nelson's Monument, injured by Lightning on the evening of 4th February 1863. By Professor C. Piazzi Smyth.

The portions of sheet-lead above mentioned had attracted my atten-

tion on the days following the 4th of February, when engaged in repairing some damage which had then occurred to the electric wires connecting the Nelson Monument and the Observatory; and finding that plumbers (employed by the Town-Council) were removing the old lead and substituting new in its place, and being also encouraged by Professor P. G. Tait, who with me visited the spot, to believe that the markings which had been discovered were electrically of unusual interest, I lost no time in applying to Mr J. D. Marwick, town-clerk, for those portions of the leaden covering which contained the marks in question, with the view of presenting them to the Royal Society.

Mr Marwick was as obliging as prompt in responding to such a request, and sent me the required specimens next day, accompanied by the enclosed memorandum written by Mr H., assistant to Mr Cousin, city-architect.

10th February 1863.

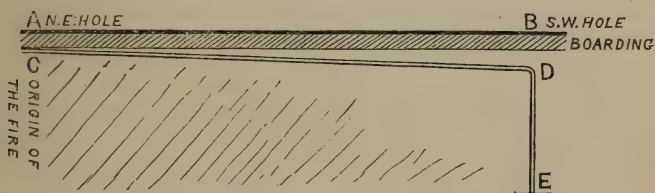
"The accompanying pieces of lead were taken from the north-west side of the lead platform on the roof of the lower part of Nelson's Monument.

"The distance between the holes was about nine feet six inches.

"Both holes were immediately over a block-tin gas-pipe, which is here carried under the lead and boarding of the platform, and which was found melted the whole length between the two holes, and a foot beyond the north-east hole.

"These holes in the lead were evidently *directly* caused by the burning gas from the pipes underneath.

Fig. 1.



"The sketch shows section through the platform between the two holes A and B. CD shows the gas-pipe under and between them.

"From this sketch we might naturally expect a hole melted in the lead at A, the pipe being here at its highest level immediately under the boarding, only one inch from the lead.

"The pipe between C and D would very quickly be melted by the burning gas, as it lies horizontally and can be more easily acted on by a flame issuing from it.

"At D the pipe dips vertically about eighteen inches.

"It is evident that the *vertical* length of pipe DE would not be readily melted by the strong flame burning at D.

"The boarding and lead at B, immediately over D, would there-

fore be exposed to the flame of the gas for a much longer time than any part between A and B. And here we might expect what we find, a large piece of the boarding burnt, and the larger of the two holes in the accompanying pieces of lead.

“How the gas was at first ignited remains to be shown.

“H.”

The above memorandum gives an excellent matter-of-fact description of what chiefly remained to be seen at the time when it was written, but it does not mention what had much struck me several days previously, when I first caught sight of the small and neat oblong hole in the roof at A; and, on subsequently pulling up the leads, which at that time had not been disturbed at that place since the storm, I found the under surface of the metal strangely burred and scored around the aperture, and also perceived small globules of melted lead, driven away apparently by some radiating force from the hole, until caught and jammed between the remaining uninjured lead and its wooden surface of support.* Neither does the memorandum account for the first igniting of the gas, but expressly says, that what may have caused that “remains to be shown.”

This is in truth the most important part of the whole affair, and which I will now endeavour to describe.

The evening of the 4th of February 1863 ushered in one of the most violent storms of thunder and lightning that has been experienced in Edinburgh, and perhaps in most parts of Scotland, for many years, and its violence was all the more remarkable, inasmuch as the month of February is near the minimum of the year for electrical manifestations in the shape of thunder-storms. This point, not yet generally acknowledged, is indicated pretty certainly by the following numbers, extracted from the Registrar-General's printed Reports for Scotland; they are, in fact, the deductions prepared for that officer at the Royal Observatory, Edinburgh, from the schedules of fifty-five observers of the Meteorological Society of Scotland, and give, for the means of three years, as follows:—

	Number of Stations at which Lightning was seen.	Mean Number of Times at each Station.
January, . . .	34	4
February, . . .	11	2
March, . . .	42	3

* These globules had very imperfect adhesion, and had mostly dropped off when the plate was presented to the Royal Society; but some few of the more distant ones still remained, and all the others had left marks, usually of a yellowish colour, showing their former positions, sizes, and shapes.

	Number of Stations at which Lightning was seen.	Mean Number of Times at each Station.
April, ...	24	4
May, ...	86	5
June, ...	85	7
July, ...	91	7
August, . . .	54	3
September, . .	31	3
October, . . .	50	8
November, . .	30	4
December, . .	37	4

The storm, then, was anomalous in its season of occurrence, and in its violence; also, as it would appear from the newspaper accounts, by the regularity and broad spread of its passage over the country from west to east, occurring nearly an hour earlier at Greenock than at Aberdeen or Edinburgh. In Glasgow and its neighbourhood several buildings were struck, a tall chimney and a church entirely ruined; a lodging-house of operatives injured in every floor; and a large number of the telegraph instruments of the Private Telegraph Company thrown out of order, and one clerk rendered senseless.

This storm began in Edinburgh about 7^h p.m., and lasted nearly an hour; it came with very strong west wind, and accompaniments of rain and hail; and it was described to me by Mr Wallace, who was on the Calton Hill at the time, as being most remarkable for the slanting, almost horizontal, direction of the lightning, as well as its greenish-blue colour. The thunder was at the same time deafeningly loud, and on one occasion apparently coincident with the flash; shaking the house he was in (the old Observatory Tower), and giving the idea that either that building, or the Royal Observatory, must have been struck. Going out immediately to see what might have happened, he met the servant at the door, who spoke of the flash of lightning having entered the lowest room of that tower, "gone half way across the floor," and left an overpowering smell of "brimstone" behind; and also called his attention to Nelson's Monument, about 200 yards east-south-east of them, being apparently on fire, because sparks were issuing from the roof of one of the low rooms at its foot, on the western side.

Now, at the winter period of the year, it seems that the tenant there (Mrs ———) finding the above monumental building very cold, prefers to live in a wooden house close by, and on the evening of the 4th of February she was in that house ill and in bed; but when the particular flash occurred which had been so much noticed by Mr Wallace and the Observatory servant, it seemed close to her

also, filled her house with the brimstone odour, and so firmly impressed her with the belief that the Monument had been struck, that she sent out her servant "to see if the time-ball was still at the top of the building;" believing that if mischief had occurred anywhere from lightning, it would be near the summit of the structure. The answer, however, brought back was, that the time-ball was quite safe, but that sparks were coming out of the roof of the low west room. The policeman of the hill was likewise on the ground almost immediately after the flash, and testified both to the then sudden appearance of sparks issuing from the roof of the uninhabited room, and its accompaniment, by the traditional sulphurous smell in the air of strong lightning, or "ozone."

The door of the Monument was then speedily opened, access to the roof obtained, and the new-lit fire, caused by the burning of gas and wooden rafters, speedily extinguished. In this manner the gas, no doubt, after it was set on fire, did much mischief to both leaden roof and wooden rafters, especially at the place on the sketch marked B, which contains big and rather confused holes; but if any one still asks what first set the gas on fire, I think there is equally little doubt that we may answer "it was that particular slanting flash of local and ozone-producing lightning which excited the residents on the hill so much at the time."

We may probably also assume that the lightning struck at the point A. I had already been directed to that point from the similarity of the hole there, to a lightning hole in sand, but could not imagine why the fluid should have pierced a hole through a good conductor, viz., a sheet of lead. On mentioning this difficulty to Professor Tait, he remarked, "that if the hole was due to the immediate action of the spark, I might be quite sure that there was a conductor below, which the lightning was trying to get at and pass off by," and *after* that opinion had been so expressed, the lead was lifted at the place (it had previously only been raised at B), and the gas-pipe was found precisely there at its closest point of approach anywhere to the roof, as may be seen clearly represented in the assistant architect's subsequent and independent drawing.*

However anomalous, therefore, the case may appear at first, some theoretical principles are remarkably borne out by it; and that the foot of the building should have been struck, and not the top, seems to follow from the low, level and almost horizontal direction in which the lightning was sensibly observed to come, and with the wind and rain,—causing thereby the windward foot of the tall building to become for that occasion the shortest passage for the fluid to reach the ground by.

* Professor Tait has also remarked, and it seems well worthy to be noted as a memorandum for any future occasion, that it would have been advisable to have preserved the boarding at "A," as well as the lead; for the manner of action and of piercing through wood by lightning is very different to the burning action of flame; and thick wooden planking *was* everywhere interposed between the gas-pipe and the leaden roof.

In such a case, though, it may be suggested, that the long horizontal wire extending through a length of 4000 feet between the Nelson Monument and the Castle for the service of the time-gun, should have been most abundantly charged by induction. That is true; and there is little doubt but that the said wire was

Fig. 2.



The hole at "A," as it appears on the under surface of the lead;
carefully drawn full size by Mr J. M. Corner, wood-engraver.

copiously filled, and might have produced dangerous effects, had it not been furnished at either end with large copper plates in close proximity to many pronged conductors ending in wet earth, which led away innocuously the greater part of the charge. Enough however still remained to do some singular damage to the electrically controlled clocks at either end of the line. Thus, the members of one of the bundles of permanent magnets, near the pendulum-bob of the Castle clock, had their poles changed and their new attraction made rather stronger than their old; the members of a similar bundle in the Observatory window-clock had their poles partially changed; and in the interior of the Normal Mean Time clock one of the gold contact points was partially fused, and spattered on its steel spring, which was blued at that part as though by heat.

The gold contact point thus treated, it will be understood, was

in direct metallic connection at the instant with the long open-air wire; and the magnets that were altered were in indirect connection, or rather, in inductive position, for they were surrounded at the time by the wire coil of the pendulum-bob, whose composing wire is a connected continuation of the long open-air wire.

To this it only remains to add, that these lightning-made magnets at the Castle clock, when duly replaced in the bundle suitably with their new poles, have given the most steady and satisfactory results in working the control of the clock ever since.

2. Note on the Anatomical Type in the Funis Umbilicalis and Placenta. By Professor Simpson.

3. On Earth-Currents during Magnetic Calms, and their Connection with Magnetic Changes. By Balfour Stewart, Esq., M.A., F.R.S. Communicated by Professor Tait.

In two previous communications made by the author to the Royal Society of London, it had been endeavoured to show that earth-currents and auroræ, which occur simultaneously with magnetic storms, are secondary currents due to the small but abrupt changes in the magnetism of the earth which such storms denote. Earth-currents also occur during periods of magnetic calm, but they can then be rendered visible only by means of a delicate galvanometer.

Such has been constructed by Mr C. V. Walker, who has by its means registered those earth-currents which occurred during the three last months of 1851, a period of magnetic calm.

The object of the present communication is to discuss those observations of Mr Walker in connection with the simultaneous changes which took place in the values of the declination and the horizontal force component of the earth's magnetism, these changes being furnished by means of continuously acting magnetographs at Kew Observatory. By this method Mr Walker's observations were divided into three classes,—

- 1st class. Observations during moments of magnetic calm.
- 2d ,, Observations during minor magnetic disturbances.
- 3d ,, Observations during greater magnetic disturbances.

In the first of these classes a law of hours was manifestly observed, the values of the earth-currents for the hours of the night being extremely small. But in the second, and especially in the third class, the law of hours was observed to fail; and in the latter of these classes the peculiar action of disturbances was very manifest, the tendency of such disturbances being to create very strong earth-currents at the moment of their occurrence; and it is noticeable that these earth-currents were as often positive as negative.

It was remarked by the author, that the very great strength of those earth-currents, which take place at the moments of disturbance, is in favour of the theory of induction, since the peculiarity

of a disturbance is not so much a *very great* as a *very rapid and abrupt* departure of the magnet from the normal position; and since, on the theory of induction, the corresponding earth-current will be due to abruptness of magnetic change, we thus obtain an explanation why the currents which accompany disturbances are so very powerful, and also why these are as often positive as negative.

With regard to the first class of earth-current observations, or those which occurred during magnetic calm, the author believed the daily range indicated by these observations to be the induction effect of the daily magnetic change, on which hypothesis the small value of the currents for the night hours might be accounted for by the corresponding fact that during these hours the magnetic change is exceedingly small.

4. Note on a Pictish Inscription in the Churchyard of
St Vigean. By Professor Simpson.

Dr Simpson considered the inscription to be "Drosten, Son of Voret, of the family of Fergus."

5. On some Kinematical and Dynamical Theorems. By
Professor W. Thomson.

6. Note on a Quaternion Transformation. By Prof. Tait.

Monday, 20th April 1863.—PRINCIPAL FORBES, V.P.,
in the Chair.

The following Communications were read:—

1. On the Conservation of Energy. By Professor Tait.

2. On Fagnani's Theorem. By H. F. Talbot, LL.D.

3. On the Theory of Parallel Lines. By H. F. Talbot, LL.D.

An Address to His Royal Highness the Prince of Wales was adopted, and ordered to be forwarded to the Duke of Argyle for presentation.

Royal Physical Society.

Thursday, 26th February 1863.—JAMES M'BAIN, M.D., R.N., President,
in the Chair.

The following Communications were read:—

I. *On the Fossils of the Boulder Clay (Till) of Caithness.* By CHARLES
W. PEACH, Esq., Wick.

Mr Peach gave details of the various kinds of shells that occur in

many places of the boulder clay, and referred to their orders and classification, the number of species being as follows:—32 Shells, 15 Univalves, 17 Bivalves; 1 Balanus; 1 Annelide; 4 Polyzoa; 2 Sponges; 1 Coral; 1 Alga—42 total species. Of the shells, 29 are British; 2 Scandinavian; 1 Arctic. All the others are British. He stated that the clay might be traced all over Caithness, especially in the estuaries and the sides of rivers and burns. Some sections showed a depth of 60 or 80 feet; while in other places, from low-water mark, it rose a height of 200 feet and upwards above the level of the sea. It differed greatly in constitution in the same locality. In some places shells were abundant, with very few stones, the clay being pretty soft; in others, stones were abundant, shells rare, and the clay so compact that it could not be blasted with gunpowder. Occasionally it contained large blocks of stones, such as granite, porphyry, gneiss, quartz, &c., some of which contained fossils, which were all more or less worn and polished.

II. *Observations on British Zephytes.* By T. STRETHILL WRIGHT, M.D.

III. *Notes on Ophrydium versatile.* By Mr W. R. M'NAB.

Wednesday, 25th March 1863.—JAMES M'BAIN, M.D., R.N., President, in the Chair.

The following Communications were read:—

I. *Notes on some Surgical Homologies.* By A. M'K. EDWARDS, Esq.

II. *On the Osteological Homology of the Vertebrate and Articulate Classes.* Part I.—The Cranium. By Professor WILLIAM MACDONALD, St Andrews.

III. *Note of a Fireball, recently observed near Auchterarder.* By JOHN ALEX. SMITH, M.D.

In the beginning of the month of February, a notice appeared of the descent of a so-called aerolite upon the farm of Drumtersal, near Auchterarder. Lieutenant-Colonel Hunter, who saw the fall, favoured Dr Smith with details regarding the phenomenon. The fire-ball fell on Tuesday the 27th of January, at five minutes to five p.m. The day had been beautifully bright with sunshine; the sun had set for eighteen minutes, it was however still full daylight, when Colonel Hunter's eye was attracted by the descent of a most brilliant luminous body. Its fall was nearly perpendicular, and it had the appearance of being the size of a twenty-four pound shot. It seemed to fall in a lea field. Colonel Hunter's gamekeeper also saw it, from another direction, apparently fall in the same field, and after twenty-four hours had passed, with heavy rain, he went to see if he could discover anything. His eye was soon attracted by the peculiar appearance of a stone which lay in the place where the meteor seemed to fall. The stone was twelve ounces in weight, had a sulphurous smell, and the grass round about it was blackened. Part of the stone was examined by a chemist who recently published the result of his analysis, and stated, among other components, that it contained 17.22 per cent. of sulphuret of nickel.

From the fact of no report of any kind being heard when the ball was seen to fall, Dr Smith was very doubtful of any stone-like body having fallen,—a loud report generally accompanying the fall of an aerolite. He fancied the ball must therefore have consisted simply of gaseous

or electrical agencies, the resistance of the atmosphere to its rapid passage through it being apparently so slight as to cause no noise. He was aware also of the danger of any peculiar or unusual-looking stone lying near the place where an apparent fall had taken place, being mistaken for the actual body that was apparently seen to have fallen there. The analysis, however, was decidedly against this view of the case; and Colonel Hunter politely forwarded to him the mineral mass for examination, and some of its broken portions, to allow of the correctness of the analysis being tested. On examining the mass, Dr Smith found no traces of the dark-coloured outer coating or skin which exists on ordinary meteoric stones, depending, it is believed, on the fusion of their surface, by the heat evolved in their passage through the atmosphere; but, instead, the surface was rough and irregular, showing on one side various cubical coaly-looking masses; and on the other the coaly-like matter projecting through a series of thin layers, apparently of white sulphuret of iron, or white iron pyrites. The specimen appeared to be a portion of one of those small seams of white iron pyrites, which are not uncommon in our coal seams. On showing it to various friends—Professor Allman, Dr M'Bain, Mr Alex. Bryson, and others—they all agreed with him, there could be no doubt of its being simply a mass of white iron pyrites. The existence of the sulphurous smell in its gradual decomposition, after exposure to continued rain, was, of course, to be expected from its composition as a sulphuret of iron; and the same would also account for the blackened appearance of the vegetation round the mass of pyrites. The broken portions of the stone Dr Smith put into the hands of Dr Murray Thomson, telling him nothing of its history, and requesting to know if it contained any metal besides iron; and was favoured with a reply, stating that he had made a lengthened examination of the substance sent him, and could detect no traces of anything besides iron, sulphur, and a little siliceous matter.

IV. *Remarks on a "Raised Beach" at Ardross, in the County of Fife.*

By the Rev. WALTER WOOD, Elie. Communicated by JAMES M'BAIN, M.D., R.N.

Wednesday, 22d April 1863.—JAMES M'BAIN, M.D., R.N., President, in the Chair.

The following Communications were read:—

I. *On the Evidence of the Rise of the Shores of the Firth of Forth.* By ALEXANDER BRYSON, Esq.

Mr Bryson described various places on the shores of the Firth of Forth, to show that there was not the slightest evidence to be found of any rise of level, at least in recent times. He referred to the rock at Cramond sculptured with the Roman eagle, believed by antiquaries to be the work of the Romans; and showed that it was now just above high-water mark, so that, if a rise of 25 feet, as has been assumed, or indeed any rise at all, had taken place since that time, this rock must have been entirely under water at the Roman period. He also alluded to the position of the Roman wall at Carriden, and showed that no remains of it had been visible for at least 200 years back; so that no evidence of any kind could be got from it. He also pointed out the existence of an extensive fluvial or fresh-water deposit at the mouth of the Almond at Cramond, without any included marine remains, the existence of which would have been impossible had any great rise of the land taken place here.

II. *Remarks on a Peruvian Skull.* By JAMES M'BAIN, M.D., R.N.

Dr M'Bain stated, there was no foundation for the assumption that the crania of the ancient Peruvians always showed additional or wormian bones in the lambdoidal suture of the skull.

III. *On the Occurrence of the Rosy Feather-Star, Comatula rosacea, on the Eastern Shore of Scotland, especially that of Caithness.* By CHARLES W. PEACH, Esq., Wick.IV. *The Kjökken-Möddinger of Denmark, and their similitudes on the Elginshire Coast.* By the Rev. GEORGE GORDON, LL.D., Minister of Birnie.V. *Notes of Bones of the Ox and Dog, and a curious Bronze Implement found in a bed of undisturbed gravel at Kinleith, near Currie, Mid-Lothian.* By JOHN ALEX. SMITH, M.D.

The bones and bronze implement (exhibited) were found in the valley of the Water of Leith, at a depth of about 12 feet from the surface, in a bed of gravel, which was covered by a bed of undisturbed sand and silt, about 5 feet in thickness. Dr Smith had seen no notice of any weapon of a similar character having been found in Britain or Ireland; it was, however, closely analogous to "a crescent-shaped" implement of bronze discovered at Steinberg, one of the ancient piled lake-dwellings of Switzerland, which is figured in M. Troyon's work on these lake habitations.

Botanical Society of Edinburgh.

Thursday, 12th March 1863.—Professor BALFOUR, V.P., in the Chair.

The following Communications were read:—

I. *Notice of Pandanus odoratissimus (Fragrant Screw-pine), now flowering in the Palm-house at the Royal Botanic Garden.* By Professor BALFOUR. (Plate III.)

Pandanus odoratissimus has recently produced pistilliferous flowers in the Palm-house at the Royal Botanic Garden. The plant is a native of the East Indies, China, and the Islands of the Pacific Ocean. The plant in the garden is about fifty years old, and has attained a height of 40 feet, with a stem about two feet in circumference. It has sixteen large alternate branches, and is provided with sixty aerial roots, some of them five feet long. (Plate III. fig. 1.) The leaves vary in length from three and a half to five feet. The plant has produced two globular spadices of pistillate flowers (fig. 2). As no staminate flowers have appeared on any of the plants in the Palm-house, the fruit will not be perfected. The fragrance is chiefly confined to the staminate flowers. The plant is used for hedges and for various economical purposes, such as the preparation of matting, bags, baskets, &c. A specimen of the pistilliferous spadix was exhibited. The species, so far as known, has not previously produced flowers in the botanic gardens of this country.

Explanation of Plate III.

Fig. 1. Sketch of plant in the Palm-house of the Edinburgh Botanic Garden.
Fig. 2. Branch with leaves and globular cluster of fruit.

II. *On a Method of taking Impressions of Plants by means of Printers' Ink.* By WALTER ELLIOT, Esq., of Wolfelee.

Mr Elliot explained to the meeting his process of taking impressions of fresh plants by means of a press and printers' ink. The specimens are covered equally on both sides with the ink by means of a roller, and then placed in the press between sheets of paper, and pressure applied. The whole process is exceedingly simple, and may prove useful to travellers. The press in operation was exhibited.

III. *Remarks on the Economical Use of the Carnauba Palm* (*Copernicia cerifera*). By Professor ARCHER.

IV. *Notes regarding some new and rare species of British Mosses.* By Mr JOHN SADLER, F.R.P.S.

V. *Register of the Flowering of certain Spring Plants in the Open Air at the Royal Botanic Garden, Edinburgh.* By Mr M'NAB. (Second list.)

	1863.	1862.	1861.
Knappia agrostidea, ...	Feb. 13	.....	.....
Symplocarpus fœtidus, ...	... 15	Feb. 26	Feb. 9
Daphne Mezereum, ...	... 16	.....	.....
Tussilago nivea, ...	... 18	.....	.....
Muscari botryoides, ...	... 20	... 22	... 26
Dondia Epipactis, ...	... 23	... 28	... 1
Orobus vernus, ...	... 25	.....	Mar. 4
Arabis albida, ...	... 28	Mar. 8	... 6
Scilla bifolia, cœrulea, ...	... 28	Feb. 20	... 7
Ribes sanguineum, ...	March 2	.....	.....
Scilla bifolia, alba, ...	... 4	Mar. 10	... 9
Erythronium Dens-canis, ...	... 4	... 15	... 14
Draba aizoides, ...	... 4	.....	.....
Orobus cyaneus, ...	... 6	.....	.....
Narcissus pumilus, ...	... 8	Feb. 27	... 6
Primula nivalis, ...	... 8	.....	... 12
Puschkinia scilloides, ...	... 9	Mar. 16	... 18
Scilla sibirica, ...	... 10	... 17	... 8
— bifolia, rubra, ...	... 10	Mar. 12	.....
Corydalis nobilis, ...	... 11	.....	... 12
Pulmonaria mollis, ...	... 11	.....	... 12
Hyoscyamus Scopolia	... 12	.....	... 9
— orientalis, ...	... 12	.....	.....

A letter was read from Professor Martius of Erlangen, to Professor Balfour, in which he says:—"I wish to call your attention to the fact, that the seeds of *Abrus precatorius* contain an alkaloidal poisonous matter. It is easily obtained by boiling the crushed seeds several times

with alcohol of 0·830 to 0·812, filtering, and then distilling the alcohol until two ounces remain per pound of seeds. If it stands a long time, the poisonous matter crystallises out. Weak alcohol exhausts the colouring matter."

Thursday, 9th April 1863.—Professor MACLAGAN, President, in the Chair.

H.R.H. the Prince of Wales was elected an Honorary Fellow of the Society.

A congratulatory address to H.R.H. the Prince of Wales on the occasion of his marriage was adopted.

A memorial to the First Commissioner of H.M.'s Office of Works, asking for more accommodation at the Botanic Garden for the Herbarium and Library of the University, was also adopted.

Professor Balfour read a short notice of the death of Mr John Wright Brown, who had acted for six years as assistant in the Herbarium department of the University Museum.

The following Communications were read :—

- I. *Note on Lemania variegata of Agardh.* By GEORGE LAWSON, LL.D., Ph.D., Professor of Chemistry and Natural History in the Queen's University of Canada.

(This paper appears in the present number of this Journal.)

- II. *Some Account of Paullinia sorbilis and its Products.* By T. C. ARCHER, Esq., Director of the Industrial Museum of Scotland.

- III. *Notice of Observations by F. COHN, Breslau, on the Contractile Filaments of the Stamens in Thistles.* Communicated by Dr ALEXANDER DICKSON.

(This paper will appear in next number of this Journal)

- IV. *On an Easy and Effective Style of Nature-printing.* By Mrs STIRLING of Kippenross. Communicated by T. C. ARCHER, Esq.

Take some finely powdered lamp-black, mix it smoothly with fine almond oil and a small proportion of pale drying oil, till of the consistence of very thick cream. The paper used should be of a soft spongy kind. Smooth crayon paper or fine Bristol board is best; a hard, rough-grained paper will not answer well. Take a small branch where the leaves are nearly perfect. As accuracy is chiefly required, it is better to lay the branch face downwards on your paper, and with a pencil lightly trace out the stem and side branches, marking where the principal groups of leaves lie,—this will ensure a more faithful copy than sketching the branch by sight. Place the branch upright before you in a pot of wet sand, and then you can either strip off these leaves and print them, or by having other branches beside you, you can select leaves resembling those of your model, remembering that the side of the branch next your right hand is on the *left* of the paper. Take the finger off a clean white kid glove, put a small bit of jeweller's cotton into it, so that when you put the glove finger on the first finger of your right hand, the cotton forms a

soft cushion at the end. Fold some soft paper in several folds, upon this lay the topmost leaf, or group of leaves, face uppermost; take some of the black upon your first finger and smear it over the leaf (or leaves) quite evenly and quickly; lay them down on your crayon paper in their right position; put a thin piece of paper over them, holding it quite steadily, and rub each leaf firmly all over, following the veins of the leaves, running your finger from the stem to the point, and from the midrib to the edge. Each bit should be done at once; going over the same part twice often causes a double impression. Raise the leaf quickly when done. In blacking the leaves include the footstalk; it will never make a perfect impression, but serves to mark the outline, and forms a guide for you afterwards. No blots, or thicker portions of the black must be allowed; they will make a blotch in the impression. Work downwards from the top of the branch. When all your leaves are finished, take lithographic chalk and draw in the whole of the stem, branches, and footstalks, marking any irregularities, knots, or buds, as these should be finished with equal care and accuracy. Lithographic chalk has the advantage of fixing at once, and blends better with the printing than any crayon or glossy pencil. As to the capabilities of this process, I found that a group of acacia or elm leaves could be done together; the horse-chestnut, ash, or walnut leaves, require to be separated. No very glossy or very rough leaf will take the black sufficiently to make a good impression. All the leaves must be perfectly fresh. I have done a series of forest trees, including several of the fir tribe. These last print very imperfectly, but still well enough to show the character of the tree, and the imperfect parts can be filled in with chalk. I have also done a number of the ferns, the difficulty with them being solely in their size; but I divide them into suitable portions, and no break is discernible in the impression. I thus managed to print both the *Osmunda regalis* and the common bracken. If the surface you have to blacken is too large, the first bit you do becomes dry before the rest is finished. Many flowers are capable of being printed.

- V. *Notice of the Tallow Tree of China* (*Stillingia sebifera*), lately introduced into the Punjab. By WILLIAM JAMESON, Esq., Saharunpore. Communicated by Professor BALFOUR.

- VI. *Memorandum on Local Museums in the Punjab.* By HUGH CLEGHORN, M.D.

- VII. *Notice of an Ash Tree struck by Lightning at Dunipace.* By the Rev. THOMAS ROBERTSON.

Mr Robertson gave some account of an ash tree which was struck by lightning on 14th June 1849, of which he was an eye-witness. The tree, which was of large size, grew close by the Avon Burn, and near the manse of Dunipace.

- VIII. *Register of Plants in Flower in the Open Air at the Royal Botanic Garden.* By Mr JAMES M'NAB.

1. *Third Spring List* :—

Asarum europæum, March 15.
Saxifraga crassifolia, March 18.
Fritillaria imperialis, March 22.
Dalibarda geoides, March 28.
Corydalis solida, March 24.

Narcissus moschatatus, March 25.
 ———— *Pseudo-Narcissus*, March 28.
Anemone nemorosa, April 2.
Adonis vernalis, April 7.

2. *List of Plants in Flower in the Open Air on 9th April 1863, not hitherto recorded as flowering at so early a date in the Botanic Garden.*

Rhodora canadensis.
 Rhododendron alta-clarense.
 ————— ciliatum.
 Rhodothamnus Chamæcistus.
 Phyllodoce cærulea.
 ————— empetriformis.
 Andromeda tetragona.
 Bryanthus erectus.
 Potentilla alba.
 Euphorbia gloriosa.
 Saxifraga tridentata.
 Epimedium alpinum.
 ————— violaceum.
 ————— rubrum.
 Lepidium procumbens.
 Draba confusa.
 Cochlearia officinalis.
 Alyssum saxatile.
 Dicylra spectabilis.
 Fumaria lutea.
 Ranunculus montanus.
 Anemone apennina.
 Crespidium Richei.
 Symphytum tauricum.
 Holosteum umbellatum.
 Sesleria cærulea.
 Luzula sylvatica.

Luzula pilosa.
 Carex montana.
 ————— japonica.
 Helonias bullata.
 Sanguinaria canadensis.
 Equisetum arvense.
 Iris reticulata.
 Tulipa Gesneriana.
 Hyacinthus orientalis.
 Leucocoryne alliacea.
 Ornithogalum exscapum.
 Narcissus Tazetta.
 ————— odorus.
 Scilla italica.
 Primula ciliata, purpurata.
 ————— Polyanthus.
 ————— marginata.
 ————— viscosa.
 ————— integrifolia.
 Pulmonaria virginica.
 Jeffersonia diphylla.
 Erica hybernica coccinea.
 ————— alba.
 ————— minor.
 Trillium grandiflorum.
 Sieversia triflora.

3. *List of Fruit and other Trees in Flower, and with Buds far advanced towards flowering, on 9th April 1863.*

Cherry, gean, pear, plum, apricot, currants, gooseberries, in full flower. Apple and thorn, some of the buds almost open. Elm, Norway maple, Canadian mespilus, *Pyrus nivalis*, in full flower. Thorn in full leaf, covered with the fruit of 1862. Thorn in full leaf, with the leaves of 1862 still green.

Mr John Reid, manager of the Edinburgh and Leith Gas Company, presented a large specimen of a new gas-coal from Gorebridge, near Arniston, accompanied with the following analysis:—Products from 168 lbs. of coal—Oil tar gas and volatile matters, 82 lb.; coke and ash, 86 lb.; gas, in cubic feet, 560=11,333 cubic feet per ton; specific gravity of gas, temperature 53°, 580·7, air=1000; heavy hydro-carbons, condensed by bromine, 15·5; carbonic acid, condensed by potash, 0·25; duration of 1 foot of gas in maintaining a flame from single jet 4 inches in length, 83·3 minutes; illuminating power by photometer, 27·94 stand. candles.

SCIENTIFIC INTELLIGENCE.

ZOOLOGY.

Syrrhaptes paradoxus.—The following paragraph appeared in the "Times" Newspaper of 6th ult. :—

"SIR,—Another specimen of this remarkable bird has met its death on British soil, and narrowly escaped passing into oblivion unhonoured and unknown. Shot by some unknown person, the precise locality also as yet unknown, it was received on the 1st inst. from Perth, in a basket of leverets, rabbits and pigeons, forwarded to Mr A. Ruthven, wholesale game-dealer of this town, for sale in the ordinary way of business, without note or comment of any kind. By Mr Ruthven it was kindly given to Mr Thomas Littler, who presented it to this museum. It was a very fine adult male, and had apparently been dead a day or two.—I have the honour to be, Sir, your obedient servant,

"THOS. J. MOORE, Curator.

"DERBY MUSEUM, WILLIAM BROWN STREET,
Liverpool, June 6."

The appearance of these birds in this country of late years is very curious and remarkable, and the questions arise, What is the cause? Have they been previously overlooked? Specimens of the bird were formerly extremely difficult to procure, not perhaps from the scarcity of the species in the districts which it frequents, but from inaccessibility of the districts, and the general difficulty of procuring anything from them which was out of the ordinary line of commerce. The opening up of China made them more common, and specimens brought by Mr Swinhoe from the neighbourhood of Pekin were sold at a moderate price. This will not, however, account for the appearance of these birds in Great Britain.

I have received a note from Professor Dickie of Aberdeen which may throw some light on Mr Moore's letter in the "Times," and the specimen forwarded to Liverpool was either part of the same flock of birds which went on to Aberdeenshire, or of other flocks driven over to us under the same circumstances.

ABERDEEN, June 1, 1863. DEAR SIR WILLIAM,—“Two specimens of *Syrrhaptes pallassii*, Temm., were shot on the coast near this at Murchals, seven miles to south of Aberdeen. There was a flock of at least fifteen. Mr Carfrae, the curator of our Museum, directed my attention to the specimens, they having been given him to stuff.”

Professor Dickie has also enclosed the following notes from his intelligent curator, Mr Carfrae. The food they selected in this country and manner of fight, &c., are all interesting points :—

“They were shot near Stonehaven, May 28, 1863—Weight of two specimens, 1 lb. 9 $\frac{1}{4}$ oz., 1 lb. 9 $\frac{1}{8}$ oz. avoird. Size—extreme length, 18 $\frac{1}{8}$ inches; breadth, 25 $\frac{1}{2}$ inches. Bill, bluish, darker at tip, slightly compressed and depressed. Nostrils, small, basil, covered with feathers. Iris very dark. Ears, external apertures *very large*; the colouring agrees with all the descriptions I have seen. Stomach very muscular, inner layer of a horny consistency, intestines short or medium length. Crop large, and filled with turnip and grass seeds; the birds were in fine condition, fat, and apparently healthy; there were about twelve or fifteen in the flock when first seen; they were very shy, and flew very quickly, but low; they have not been seen in the neighbourhood since; the bones, &c. of the specimens are in the Museum here.”

W. J., ED.

BOTANY.

Botanical Collector in British Columbia.—Mr Robert Brown, the Botanical Collector sent out by the British Columbian Association, reached Victoria, Vancouver's Island, on 6th May 1863, and has now commenced his examination of the Flora of the Island.

Cinchona Bark.—The Red Bark grown in India, after two years' growth, has been found to yield quinine in the same quantity as the same species of Cinchona in South America. In Mr MacIvor's report of 31st March 1863, it appears that there are now 146,548 Cinchona plants in the Nilghiri Hills, 35,750 of which have been planted out. A qualified gardener is about to proceed to Darjiling to superintend Cinchona plantations there.

MISCELLANEOUS.

Dr Hector's Exploration of New Zealand.—The following notice has been contributed to the "Otago Daily Times" by one of Dr Hector's party. It is dated "Left Bank of the Matukituki River, March 8th, 1863." After alluding to the preparations made for the expedition to the West Coast, he says:—

"Proceeding up the valley of the Matukituki, we found it to preserve the same character for several miles, viz., a broad shingle channel, out of all proportion to the magnitude of the stream, and only very partially occupied by it. Our progress was slow, so that by the evening of the first day we had only accomplished seven miles. A dense fog continued to obscure the higher mountains from our sight. Early next morning I obtained my first view of the icy pinnacles of Mount Aspiring, its apparent altitude being greatly increased by the rolling mist which still enshrouded its base. Mount Aspiring is one of a group of lofty mountains, all of which it evidently overtops by a pyramidal mass of rock almost too steep to allow of eternal snow resting on its surface, and which forms the characteristic feature by which it might be recognised almost at any distance. About ten miles above our main camp, the Matukituki is formed by the confluence of two equal-sized branches. The one from the north, although the shortest, may be properly considered the main stream. The other, which sweeps from the west, joins it through a rocky defile, which at first sight we anticipated would offer an obstacle to our progress. We were, however, surprised to find it occupied by an open flat, fringed by noble forests of beech, which clothe the mountain sides also to the height of about 2000 feet. A short distance above the junction of the two branches, we forded the stream. The scenery for two miles above this ford is extremely beautiful. The mountains on either hand are to be seen furrowed by impetuous torrents issuing from the snow at their summits, and gaining the level of the river by a succession of wild leaps. One of the most strikingly picturesque of these cascades descends by six precipitous bounds from an altitude of about 1200 feet, forming graceful curves of white spray that are momentarily swayed into fantastic shapes by every gust of wind. The dark green shades of the massive beech forests along the base of the mountains also, are relieved at intervals by the pale verdure of patches of Mallow trees, which at this season were covered with their snowy white blossom.

"On the 13th February, we recrossed the river, and making a considerable ascent on its right bank, gained the elevated terrace which borders the gorge immediately below M'Kerrow's Flat. The tangled nature of the scrubby vegetation in this portion of the valley, and the frequent succession of deep gullies, rendered our progress so slow and tedious, that Dr Hector struck off to the river, and succeeded in finding a more practicable track by which to avoid the labour of hewing, as well as

a means of again descending into the immediate valley of the stream. In the gorge, the channel is beset with huge boulders, rendering the river for some distance a series of foaming rapids, as well as preventing any track being practicable along the edge of its waters. Just above the gorge, through a narrow fissure in the mountains, there is a fine view of the glaciers which clothe the southern flanks of Mount Aspiring.

"The Matukituki in this part of its course flows due south, and we were now within a few miles of the boundary line of the Province of Canterbury, which crosses it at right angles, and opposite to a depression in the mountains to the westward which from a distance had seemed favourable to our further progress to the west, and from which there issued a large tributary to the river. As it was Dr Hector's wish to keep as close to the boundary line as possible, and within the province of Otago, he devoted the 15th in searching for a pass in this direction. By a laborious climb, he ascended the mountains to a height of about 5000 feet, but could observe no available route, as the extent of the nick, or depression, was deceptive, and confined to the exterior range bordering the valley; while to the westward a succession of lofty mountains rose from an extensive *mer de glace*. To the north, however, he perceived that, by following the Matukituki to its source, a comparatively low saddle would lead into a region of country in which the mountains appeared to have a lesser elevation. He resolved, therefore, to make the first attempt in this direction.

"On the 16th we continued our journey along the edge of the river, climbing over the huge boulders which are dispersed along its margin. The mountains on either side of the stream present cliffs quite perpendicular to its waters, so that we were compelled to climb a spur and pass through the woods to avoid the obstacles which they thus offered to our progress. Passing through the thick woods, which are intersected by deep cuttings choked with fern, scrub, and masses of decayed vegetation, we again descended to the boulders in the bed of the river, and following it a short distance, merged on a small plain about a mile and a half long, and occupying almost the whole breadth of the valley. We encamped here, at the foot of a strip of mountain, which some time previous had been cleared of forest by the violence of a recent avalanche. A mass of trees torn up by the roots, and surrounded by an enormous quantity of rock, lay piled around us, an indication of the tremendous power which produced such ruin. The ascent towards the source of the Matukituki from this point is very rapid, and at the distance of about three miles from it the first glacier is met. It is very insignificant, indeed scarcely deserving the name. From the ice cave, at its lowest extremity, a small stream flows to the main channel, which, both above and below their junction, is contracted and rocky, causing the river to assume the character of a series of foaming cascades. Four miles still further up the valley, we attained the limit of the woods; and although early in the afternoon, we encamped at this place, as we should get no fuel until we had crossed the saddle and descended to the limit of the woods on the other side. The altitude at which this limit on the eastern side of the saddle is observable is about 3500 feet above the sea. From this point to the base of the height of land, the river valley is extremely rugged, being occupied by old glaciers presenting the general chaos common to all moraines,—viz., a confused mass of angular and smoothly worn boulders distributed without any regard of size, or order of deposit.

"We were now at the most north-westerly portion of the province of Otago, and close to the boundary line which separates it from that of Canterbury, having followed the largest tributary of the Molyneux to its source. By a steep climb, we gained the summit of the saddle, following the course of the larger of the minor arms of the Matukituki, travelling

a portion of the distance on the uppermost glacier which feeds the river. From this point a most magnificent view was spread out before us. The high mountains to our right, with their clear blue pinnacles of ice pointing to the sky, and shrouded in enormous glaciers, presented a truly Alpine scene, while the whole valley at our feet was completely filled by a glacier occupying an area of about five square miles. This latter, as well as the mountain from which it descends, and the river to which it gives birth, Dr Hector named in honour of Mr Haast, the provincial geologist of Canterbury, that gentleman being the first scientific traveller to describe the glaciers of New Zealand. After making an examination as to the best way to descend, a task both perilous and laborious, owing to the glacialised surface of the rock composing the mountain, and the high angle of inclination of its side, we commenced our descent. For some distance we succeeded easily, but occasionally we were completely stopped by a peculiar blue rock interbedded with the slate, and which may be appropriately likened, from its undulated surface, to corrugated iron. Although we had started from the saddle at about 1 P.M., it was growing dark by the time we had gained the upper part of the small glacier to our left, and it was at least 800 feet above the true base of the mountain, or 900 above the surface of Haast's Glacier. The continual fall of avalanches and loose stones in the valley occupied by the smaller glacier rendered travelling very dangerous, and as night was fast approaching, Dr Hector thought it advisable to reascend a portion of the mountain, and avail ourselves of a hole in the rock for a night's lodgings, as well as a shelter from the falling ice.

"The night was extremely comfortless, with a high wind that howled among the mountain fastnesses, and chilled us in our rocky cave; and at intervals a crashing noise, like the outburst of distant thunder, told us of avalanches quitting their icy thrones to pay their tribute to the ocean king. Early next morning we descended to the small glacier alluded to above, and prepared to traverse it. The valley which it occupies does not exceed a mile and a half long, and about a quarter of a mile broad; but owing to the steepness of the glacier, and the deep crevasses or rents that occur in the ice, a large amount of Alpine experience and skill is requisite before attempting to cross it. It assumes also the shape of a wedge, and in consequence of its sides nowhere touching the rocks that border it on either hand, but surrounded by wide chasms instead, its impracticability is therefore rendered still more apparent. Previous to starting from Dunedin, Dr Hector, by his foresight, had provided a small-sized cord of about three-sixteenths of an inch in diameter, and eighty feet in length, similar to what is used as tracking-lines in canoe voyages on the rivers of Canada, and from its great utility to parties fording rapid rivers in this country, experience has taught us that it cannot be too strongly recommended. For instance, when crossing the strong and rapid current of a river, our method was to tie the cord to our waists, at a distance of twelve or fourteen feet the one from the other, then, while the leader was baffling with the force of the stream in the deepest and strongest part of its course, he was supported by the others until he had reached a portion of the river the force of which he was able to contend with, and at the same time afford assistance to the next in order to cross, and so on until all had gained the opposite bank. In descending the small glacier in like manner, we were thus attached the one to the other, to prevent any serious accident happening in case of slipping the foot or falling into one of those frightful crevasses, the sight of which is often alone sufficient to unnerve the stoutest heart. We encountered two very dangerous fissures in the descent. Both were too wide to leap, and we cleared them in the following manner. Dr Hector sought out the most

practicable part, where the ice on one side approached more nearly the ice on the other, and with an axe cut steps to where it was possible to leap; then he continued cutting steps in a slanting direction until he had gained the top of the ice on the opposite side of the crevasse. This being done, we attached the packs to the middle of the cord, and he pulled them across. Then with our waists carefully attached, and following the steps he had cut, we passed over singly in the manner he himself had done. We occupied two hours and a half in getting to the commencement of Haast's Glacier.

"Dr Hector having carefully examined the surface with his glass, and fixed upon the best route for avoiding the 'crevasses,' took the lead, three of us being lashed together as before by the rope. At first we had to ascend the glacier for some distance, to head a wide and profound crevasse compelling us to pass among blocks of ice and stone, the debris of avalanches which fall every ten or fifteen minutes from the higher part of the glacier. Luckily for us, by hurrying on we passed this danger during an interval, but had scarcely got beyond its reach when one of the most tremendous avalanches that we had witnessed came rolling down, sending blocks of solid ice of many tons in weight to within a few yards of where we stood, while the place we had so recently passed was overwhelmed with smaller fragments and masses of rock. The height from which this ice cascade descends is about 1500 feet, and the mass of ice thus formed into a glacier is probably not less than 500 feet in thickness at its upper end, and at its lower about 100 feet. Its length is five miles, and in that distance the slope of its surface amounts to 1100 feet.

"We occupied the same time in crossing Haast's Glacier as that in descending the smaller one already alluded to, viz., $2\frac{1}{2}$ hours, and at its completion we encamped a few yards below where the river of that name commences its hurried course. Four and nine miles from its source, the river passes through gorges with an enormous velocity, and so rapid is the descent of its valley, that viewing tall trees at a comparatively short distance off, their tops are seen on a level with the eye. Dr Hector ascertained its fall in this part of its course to be 7 in 30. Continuing our course for about six miles further, we were arrested in our progress by a precipitous cut cliff, which for about 100 feet above the surface of the river is quite devoid of vegetation, and presents a perpendicular smooth surface. Considering that we had been travelling the whole distance down the stream in a northerly direction, and thereby penetrating into the province of Canterbury, Dr Hector felt that he was thus on ground beyond the limit of his especial duties. Having, however, taken so much trouble in contending with the difficulties of this district, he would obtain as much information as possible relative to the mountainous region to the westward, before proceeding any further by the valley of the Haast. The following morning we proceeded along the summit of the ridge to the highest point of the mountain, when, to our great delight, the ocean shore lay stretched before us at the distance of about fifteen miles. From this point the whole course of the river by which we had descended was accurately traced, and it was found to sweep through a perfect canon at a distance of two miles above the point at which it debouches into a river, the valley of which ranges from three to five miles in width, and whose volume of water is at least equal to the Molyneux where it leaves the Wanaka Lake. From careful bearings, which Dr Hector had taken throughout the route we had followed, we learnt that what we saw was Jackson's Bay; he therefore named the river which flows into it the Jackson.

"The sight of the ocean was too great a temptation for us to be satisfied that we had proceeded far enough, and, although our provisions were

almost entirely consumed, we determined to push on. Keeping along the ridge, which forms the northern boundary of a thickly timbered valley that leads into that of the Jackson, we travelled for about one and a half miles before commencing the descent. From the ridge, the slope down to the former is grassy and undulating, with no timber, but dotted thickly with small lakes surrounded by peat. The whole surface of this grassy slope is cut up by numerous rents or fissures, indicating, probably, that this region had been formerly visited by earthquakes.

"It was about noon before we descended into the woods; the thick masses of decayed vegetation, overgrown by mosses and undergrowth, served to fill up the spaces between the rugged angular masses of rock, which on this portion of the Pigeon Mountain seemed to be detached from the mountain side. Great care was taken in passing over this first part of the journey, as sometimes treacherous holes lay concealed beneath a spongy layer of moss and rotten wood. The tomatacowra, that painful impediment to the traveller, does not exist in the woods of the west, and the bayonette grass, equally cruel, is of exceedingly rare occurrence. This is undoubtedly owing to the woods having never been devastated by fires. The latter fact is remarkable, and affords a strong presumption that for a great number of years perhaps never have these localities been traversed by man. A succession of deep descents, occupied by splendid timber (the *Totara* being the forest king) led us to the edge of the most thickly-clad flat which occurs at the forks of the Jackson and Haast Rivers. Just as darkness had set in we struck the margin of the latter, and, for the first time since starting, retired to rest supperless.

"The magnificence of the primeval forests of the West Coast must be seen to be thoroughly appreciated. Not only do the *Totara* and beech attain gigantic proportions, but the *Fuchsia* and *Tutu* become very large trees, averaging two feet in thickness.

"Our camp on the bank of the Haast was uncomfortable in the extreme; the rain poured down on us in torrents, saturating us in a short time, while the myriads of mosquitoes made a sortie from the bush, and kept us in a perfect state of fever the whole night. With the dawn of the following morning, the 23d, in a tropical-like flood of rain, and with no breakfast, we were fortunate enough to strike probably the only ford for some distance at about a mile above the forks, and proceeded by the flats about four miles down the valley of the Jackson. The rain had evidently set in for a lengthened period, and although this was the first long continuation of wet weather we had experienced since leaving Dunedin, it was a circumstance greatly to be regretted, seeing that we were now only about eight miles from the sea, and the rapidly increasing flood of the river was the greatest obstacle to our reaching its mouth. Taking into consideration also the density of the woods, and the distance we should have to travel before obtaining further supplies, Dr Hector thought it advisable to abandon the project of descending the valley further. The accomplishment of the journey to the very brink of the ocean, under present circumstances, would have been at a great risk; while, on the other hand, with sufficient provisions and moderate weather, the work would have been the easiest which had fallen to our share since leaving the central camp on the Matukituki."

THE
EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

*St Michael's Mount and the Phœnicians.** By R. EDMONDS,
Esq.

To the astonishment of Cornishmen, especially of those best acquainted with the subject, it was at the Truro meeting of the Cambrian Archæological Association in August last, gravely questioned whether the Phœnicians ever visited Cornwall. It is true that some authors have lately contended that the tin in Canaan in the days of Moses (Num. xxxi. 22) must have come from India. But they have done so without a tittle of evidence; there being no more reason for supposing India to have supplied Canaan or Egypt with tin 3000 years ago, because tin is now so largely exported from the Isle of Banca, than for imagining Cornwall to have then exported copper as well as tin because it does so now. Other authors have contended that the tin then in Canaan came from Tartessus, near Cadiz, the Tarshish of Scripture (Jon. i. 3; Isa. xxiii. 6; Ezek. xxvii. 12). But if Tartessus, or any other part of Spain, had in ancient times produced much tin, it would in all probability, like Cornwall, have continued to do so to the present day. No tin mines, however, appear to have ever existed in Spain, as Dr George Smith was lately informed by the College of

* Read (with the exception of the postscript) at the Annual Meeting of the Royal Institution of Cornwall on the 29th of May 1863. Communicated by the author.

Mines in Madrid in answer to his inquiries. "I cannot learn," says the writer from Madrid, "that Spain ever produced any quantity of this metal. The Government do not work any mines of tin. The quantity being produced at present is very small, chiefly by streamers, near the granite hills in Gallicia and Zamora. I cannot learn that there is any tin-mining in the country." This quotation is from a note prefixed to an excellent little work on the *Cassiterides*, published this year by Dr Smith, wherein he shows, by the most satisfactory historical and other evidence, that the Phœnicians never procured their tin from India, but always from Cornwall, with the exception perhaps of a small portion from Tartessus.

In addition to what has been stated by this learned author, I would mention a few more things worthy of being recorded.

That Mountsbay was known to Greek historians before the time of Herodotus, and as far back at least as the 6th century B.C., is shown by the following quotation from Diodorus, who was evidently not aware that the locality described by Hecatæus and the other historians was the very Belerion which he himself has described, where the tin was dug out of the earth, and near which was the island Iktin. To those, however, who are familiar with Mountsbay, this identity is very apparent. "Amongst them that have written old stories much like fables, Hecatæus and some others say that there is an island in the ocean, over against Gaul (as big as Sicily), under the arctic pole, where the Hyperboreans inhabit, so called because they lie beyond the breezes of the north wind. That the soil there is very rich and very fruitful, and the climate temperate, inasmuch as *there are two crops in the year.*" The island here referred to *can* be no other than Britain; but the only part of Britain to which the description applies is Mountsbay, where still "*there are two crops in the year.*" Whether the other writers alluded to by Diodorus lived before or after Hecatæus, we are not informed; but as Hecatæus was born 549 B.C., we may conclude that the fact recorded was known in Grecian history as far back at least as the sixth century B.C.: and from whom is it so likely to have been first related as by the Phœnician mariners, who were

then, and had been for many centuries before, the greatest and most extensive navigators in the world !*

Let us proceed with the quotation. "They say that Latona was born there, and therefore that they worship Apollo above all other gods. . . . They say, moreover, that Apollo once in nineteen years comes into the island, in which space of time the stars perform their courses and return to the same point, and therefore the Greeks call the revolution of nineteen years "the Great Year." This cycle of nineteen years, at the end of which the new and full moons happen within an hour and a half of the same times of the year, as they did at the beginning, and by which Christians have always regulated their moveable festivals, was thus apparently known to the Druids in Britain ages before Meton discovered it in 430 B.C. To it, therefore (and not to the twelve months in the year and the seven days in the week, as Borlase imagined), the four "Druidical Temples," within six miles of Penzance, may have pointed. These consisted originally each of nineteen detached stones or unhewn pillars placed upright, from three to five feet above ground, in rude circles, the smallest circle being about sixty-five, the largest about eighty feet in diameter. Each circle is vulgarly, and has been immemorially, called the "nine maidens," an abbreviation doubtless for "nineteen maidens." This I mention because some modern authors have, contrary to Borlase, contended that the original number of pillars forming each circle was more than nineteen, as it has a space between two of its pillars much wider than that between any other two. But this widest space may have been originally intended for the passing in and out of religious processions. The name *Belerion*, anciently given to the Landsend district, and the name *Druids*, by which the priests there were called, because they performed their religious rites within groves of oaks (Hos. iv. 13), as did the worshippers of *Bel* or Baal in Palestine, are quite in keeping with the supposed Phœnician origin of these four very ancient temples.

* Josh. xix. 29 ; Is. xxiii. 3, 7, 8 ; Ezek. xxvii. 3, 4, 12, 33.* It is stated in Haydn's Dictionary of Dates (8th edition) under the word TIN—"The Phœnicians traded with England for this article more than 1100 years B.C."

As Mountsbay is the only place that answers to the description referred to by Diodorus, so the Mount which gives name to that bay is the only place that coincides with Diodorus' description of Iktin. I say Iktin, because Diodorus calls it by no other name. His translators (French and English as well as Latin), assuming this barbarous name to be declinable, and finding it in the accusative case, have concluded Iktis to be the nominative, although, if it *were* declinable, Iktin might have been the nominative with as much grammatical propriety as Iktis,—particularly as the Greek word *tis* does not give *tin* at all for the accusative, but *tina*. Had they any doubt which it should be, a moment's reflection would have shown that the nominative here must, in order to agree with Diodorus' account of the mount, be *Iktin*, "Tin-port," inasmuch as Iktis has no reference whatever to tin. Were it not for this misnomer in the translations, no author probably would ever have contended that the Isle of Wight, the ancient Vectis, was the Iktin of Diodorus. Many have done so, at various times; but after the richly deserved criticisms by Dr Smith, to which they have been subjected, none, I think, will venture to do so again; not even the very bold writer in the *Saturday Review* of 8th November 1862 (p. 563), who, finding no place but St Michael's Mount to agree with Diodorus' description of Iktin, tries to stultify that author by alleging that he says, "not only the Isle of Wight, but all the islands between Gaul and Britain, can be reached from the mainland at low water," although, as we shall presently see, Diodorus says no such thing. The reviewer, in giving us what he thought the meaning of the author, seems to have forgotten that Diodorus Siculus lived in an island of the Mediterranean, and wrote for those who knew nothing about the ebbing and flowing of the sea, so that after having described the Isle of Iktin as accessible by carts "during the recess of the tide," he was obliged to explain himself, and to illustrate the effects of the tides, by adding,—“and it is something peculiar that happens to the islands in these parts lying between Europe and Britain; for at the full tide, the intervening passage being overflowed, they appear islands, but when the sea retires a large space is left dry,

and they are seen as peninsulas." This explanation of what his countrymen would have regarded as a most improbable phenomenon, is literally true ; for he does not say, as the reviewer imagines, that *all* the islands between Europe and Britain came within this description—nor indeed that any of them did, which were in deep water like the Isle of Wight ; but he speaks only of those which, like the Mount, were in shallow water and on the coast.

The only reason given by the reviewer for considering the Isle of Wight to be the ancient Iktin, is its being nearer than the Mount to Gaul, and because Diodorus says that at Iktin " the traders purchase the tin of the natives, and transport it into Gaul ; and, *finally*, travelling through Gaul on foot, in about thirty days they bring their burdens on horses to the mouth of the river Rhone." This passage, particularly the word *finally*, which I have written in italics, leads me to conclude that the tin was carried most of the way from Iktin to the mouth of the Rhone by sea, and therefore probably to the inmost part of the Bay of Biscay, and from thence by land to Marseilles, at the mouth of the Rhone, to avoid sailing round the Spanish peninsula, as was the more ancient route while Tyre and Tarshish were flourishing. And it is remarkable that the sandy parish of *Lelant* in the Bay of St Ives, only four miles from the Mount, is called by the same name as *Les Landes*, the sandy coast of the Bay of Biscay (*t* and *d* being interchangeable letters), as if the one name had been derived from the other through the tin-traders, whomust have been well acquainted with both places. Moreover, the carriage by land from the *north* of France to the Mediterranean, as the reviewer reads Diodorus, would, in those rude ages, have been not only more expensive, but more unsafe than by the route I have mentioned.

As it is now established beyond all reasonable question, that the Phœnicians came to Mountsbay for tin, both before and for many centuries after the time of Moses, and that the Mount under the name of Iktin, is the most ancient British port known to history ; it will be interesting, in conclusion, to consider the derivation of this name, and of the name of the island in which we live.

Ik is the Cornish for " port ;" *tin* is the metal so called

(as is supposed) by the Phœnicians, and the name continues unchanged in the Saxon, English, Dutch and Danish languages; but the Swedish name is now *tenn*, the German *zinn*, the French *etain*, the Latin *stannum*, the Irish *stan*, the Cornish *stea*n, the Armoric *stea*n, and also *staen*; the first letter of each of the last five names being a mere prefix, as in the modern word *sneeze* for *neeze* (Job xli. 18). With this exception, and except the termination of the Latin name, these eight different spellings are merely different ways in which different nations pronounce *tin*. *Iktin*, therefore, signifies "tin port;" and the Mount was probably thus called by the foreign tin-traders who frequented it. The Cornish or ancient Britons would have called it *Tinik*, although *porth*, another Cornish word synonymous with *ik*, rarely *follows*, but almost always *precedes*, the word to which it is joined. When other tin-ports began also to be frequented, the foreign traders may, by way of distinguishing it from the Falmouth or other tin-ports, have called it *Bre-tin-ik*, "the Mount-tin-port," *Bre* being the Cornish for "Mount;" and euphony as well as the British mode of collocating these three words, would have prevented them from calling it *Bre-ik-tin*. Assuming this to be the true derivation, it is a beautiful illustration of the fact of ancient names being originally faithful descriptions of the places or things to which they were given. For *Bre-tin-ik*, "the Mount-tin-port," was not only a mount, and one of the strongest natural fortresses to protect the tin carried thither from the mainland, but also the safest port in the bay for ships to remain in until laden for a foreign voyage. And this name, although so appropriate, was at the same time as uncommunicative of its locality as could have been desired by the Phœnicians, who, as is well known, sought to conceal the place whence they procured their tin.

As a name originally confined to a very small part of a province or country often becomes the name of the whole, so the Mount, which gives its *modern* name to the finest bay in England, may have given its *ancient* name to all Britain, not only because it was the most striking object, and the most important place in our island known to the Phœnicians, but also because this ancient name (*Bre-tin-ik*) told no more

of its locality than did the name *Cassiterides*, "Tin Islands," used by Herodotus B.C. 445. And *Bre-tin-ik* is almost *literatim* not only the name (*Brettanike*) by which Diodorus calls Britain, but also the original Phœnician or Hebrew word (*Baratanac*, "the land of tin") from which, according to the learned Bochart, our island was called.

To Cornishmen, the last survivors in England of the ancient Britons, this subject must be particularly interesting, especially when we regard Tyre, in its most flourishing condition, as typical of England at the present time,— "very glorious in the midst of the seas;" "whose merchants are princes;" and who hath been for ages, and still is "the covering cherub" (Ezek. xxviii. 14, 16), beneath whose wings fugitives from their own lands, for offences not deemed by us "worthy of death or of bonds," have always found a secure asylum.

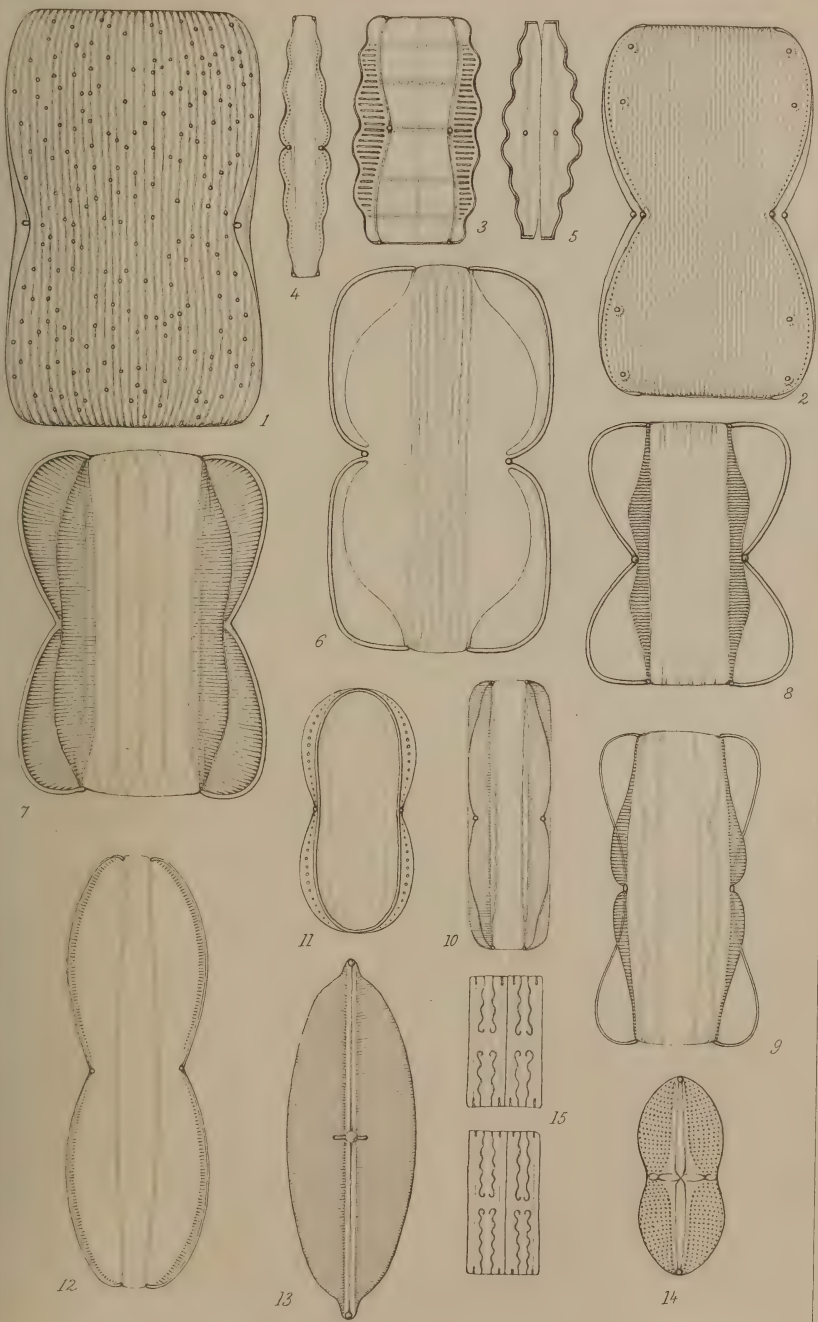
P.S.—Since writing the above I have seen the pamphlet just published of Colonel Sir Henry James, R.E., director of the Ordnance Survey, entitled "Note on the Block of Tin dredged up in Falmouth harbour." This block, presented forty years ago to the Royal Institution of Cornwall, weighs about 130 lbs., and appears to be of the very form (*αστραγαλων ερυθμούς*) into which Diodorus says the tin was cast before it was carried in carts to Iktin. "It is 2 feet 11 inches long, 11 inches wide, and 3 inches thick at the centre, perfectly flat on one side, but curved on the other, and having four prolongations at the corners, each one foot long;" thus resembling in its outline a London butcher-boy's tray, and well adapted for being carried by hand by two men; for being firmly placed on the curved bottom of a boat for exportation, and for being afterwards strapped, two of them together, to a pack-saddle with their flat sides against the sides of the horse. A plan of it is given below. The boat containing this block is supposed by Sir Henry to have been lost on its voyage from St Michael's Mount to France, at the entrance of Falmouth harbour, where it was dredged up. This publication will be printed in the next Report of the Royal Institution of Cornwall, together with a letter to Sir Henry, dated 16th June 1862,

from the late Sir George C. Lewis, stating he was satisfied that St Michael's Mount "was the port from which the tin was shipped for the coast of Gaul." The pamphlet thus concludes, "I do not think it necessary to discuss the claims of the Isle of Wight to be considered the Iktis, as the description of the place does not now, and could not at any time have applied to it in any one particular." This agrees with my own remarks in respect of the Isle of Wight.

Sir Henry has confined himself to the places where this block of tin was shipped and lost. I have elsewhere* pointed out the very spot where it was probably cast into its most singular shape before it was carried to its place of shipment. This spot is at the mouth of the stream, half a mile north of the Mount. By a temporary diversion of the stream in 1849, a deep section was made in the sand-hillock forming its western boundary. On that occasion my nephew (Frederic Bernard Edmonds) and myself discovered, two or three yards beneath the surface, remains of ancient walls rudely built of unhewn stones, and close by them great quantities of ashes, charcoal, slag, broken pottery of very rude manufacture, brick, and *fragments of a bronze vessel* resting with their outsides on charcoal. A considerable portion of the copper had combined with the charcoal during the lapse of ages, and a beautiful green substance had resulted—the carbonate of copper. Two of the fragments, each about 6 inches long, 4 wide, and only the sixteenth of an inch thick, had been evidently parts of the circular top or edge of a furnace (3 feet in diameter) bent back into a horizontal rim, three quarters of an inch broad. No charcoal was on the insides of the fragments, but their outsides were completely blackened and covered with it. Diodorus speaks of two fusions; the tin ore being no doubt, as at present, first *smelted* in contact with the fuel; and the metal, thus purified, being afterwards *melted* in furnaces by fire applied only externally. For the latter process, this very ancient bronze† furnace was probably

* The Land's End District, p. 9.

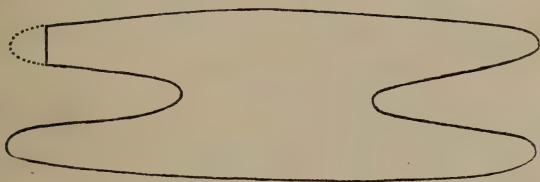
† In Liddell and Scott's Greek-English Lexicon (abridgment), 1859, it is stated that "Tin was usually melted and cast upon bronze." But it is now melted in *iron*, and the diameter of the *iron* furnace used at Messrs Bolitho'





brought and used by the Mediterranean traders as long as it continued fit for service. When the traders ceased to visit Mountsbay these forsaken ruins were gradually and completely buried beneath the sand driven in by the winds from the shore, and the turf had from time immemorial until 1849 being growing over them.

One of the bronze fragments I presented, soon after their discovery, to the Museum of Economic Geology in London, where there is also a cast of the block of tin described by Sir Henry. The other fragments, with some of the charcoal and slag, I have now presented to the Royal Institution of Cornwall, so that the block itself and a part of the furnace in which it may have been melted, may be seen, side by side, at its Museum in Truro, confirming, in a most singular manner, a passage in the history of Britain written before the Christian era.



Descriptions of New Genera and Species of Diatoms from the South Pacific. By R. K. GREVILLE, LL.D., F.R.S.E., &c.* Part II. (Plate IV.)

GRAMMATOPHORA.

Grammatophora pusilla, n. sp. Grev.—Small; septa undulate, with the inner ends incurved; undulations becoming obsolete towards the margin; striæ obscure. Length of frustule about $\cdot 0018''$. (Plate IV. fig. 15.)

Hab.—Curteis Straits, Queensland, in a dredging communicated by Dr Roberts of Sydney.

Melting House, near Penzance, is very nearly the same as was that of the bronze furnace now described.

* Read before the Botanical Society of Edinburgh, 9th July 1863.

A very delicate little species, coming nearest to *G. anguina* of Kützing, but differing remarkably in the character of the undulations of the septa, as will be perceived at once by a reference to the figures. In *G. anguina* the undulations are equal, or nearly so throughout; while in our present species the lower ones are scarcely perceptible, and each septum near the margin resembles a sort of footstalk to the upper (or inner) part. I find the number of the undulations to vary, the difference not apparently depending upon the size of the frustule.

AMPHORA.

Amphora magnifica, n. sp. Grev.—Frustules large, rectangular, slightly constricted, truncate at the ends; outer portion only visible in the middle, where it is narrow and inflected; nodule minute; dorsum with numerous longitudinal lines (about 10 in $\cdot 001''$), and brilliant scattered puncta. Length $\cdot 0040''$ to $\cdot 0055''$. (Plate IV. fig. 1.)

Hab.—Curteis Straits, Queensland.

The finest species of the genus. The whole surface is covered with numerous longitudinal lines, which have a plicate appearance, and are sprinkled over with luminous gland-like puncta. The outer portion is inflected in the middle for little more than a third of the length of the frustule.

Amphora pulchra, n. sp. Grev.—Frustules large, constricted, somewhat panduriform, with the ends truncate; outer portion very narrow, disappearing before reaching the rounded corners; dorsum with very numerous longitudinal lines, and four brilliant submarginal puncta on each side. Length $\cdot 0040''$ to $\cdot 0050''$. (Plate IV. fig. 2.)

Hab.—Curteis Straits, Queensland.

Evidently related to the preceding, but differing in the much greater constriction, in the more numerous longitudinal lines, and in the luminous puncta being limited to four on each side (two in each lobe, one of them being near the angle, and the other at no great distance from it).

Amphora undulata, n. sp. Grev.—Frustules rectangular, with truncate shortly produced ends, and four sub-equal in-

flations; striæ coarse, 14 in $\cdot 001''$. Length $\cdot 0030''$. (Plate IV. fig. 3.)

Hab.—Curteis Straits, Queensland.

This is a very conspicuous member of a little group, the frustules of which are distinguished by their constricted or sinuated margins. Three species—*A. binodis*, *angularis*, and *lyrata*—were discovered and described by my late indefatigable friend, Professor Gregory, and one, *A. Sarniensis*, was recently added by myself, from a dredging made in Guernsey by Dr Wallich. The present is the most robust species of the section, and is rectangular in shape, with the corners rounded. The whole surface is undulated.

Amphora flexuosa, n. sp. Grev.—Frustules constricted, nearly linear, with truncate produced ends, and six gentle undulations having a marginal row of very minute puncta; Nodule situated at the angle of the constriction. Length $\cdot 0034''$. (Plate IV. fig. 4.)

Hab.—Curteis Straits, Queensland.

A comparison with the following, which has also six undulations, will show at a glance that our present diatom is a genuine species.

Amphora sinuata, n. sp. Grev.—Frustules narrow, oblong-elliptical, with truncate shortly produced ends, and six undulations, the two middle ones being the largest; nodules situated at a distance from the middle sinuation; striæ obscure. Length $\cdot 0028''$. (Plate IV. fig. 5.)

Hab.—Curteis Straits, Queensland.

In the preceding species there is a true constriction, the nodule occupying the angle; in the present one there is no proper constriction, but a concave sinuation, the nodule being situated apart from it on an inner longitudinal line.

AMPHIPRORA.

Amphiprora Thwaitesiana, n. sp. Grev.—Front view somewhat rectangular, broadly truncate at the ends, the wings much rounded at the corners and then widely concave; supplementary wings striate, convex, constricted at the nodule, intersecting the primary wings, so as to divide the whole length into about three equal parts. Length $\cdot 0040''$. (Plate IV. fig. 9.)

Hab.—Curteis Straits, Queensland.

A most distinct species, and attractive from the graceful manner in which the wings intersect one another. The primary wing makes a concave sweep from the rounded corners, and touches the central portion at the nodule. I have not been able to detect the striæ in this part. The supplementary wing makes a sweep in the opposite direction, intersecting the primary one at two points, and is so constricted in the middle that the nodule lies in the angle, and appears to serve both wings. The striæ in the supplementary wing are conspicuous.

Amphiprora Kützgingiana, n. sp., Grev.—Front view broadly and rectangularly oblong, truncate at the ends, with widely rounded corners, and somewhat straight sides, suddenly and deeply constricted; supplementary wing commencing obliquely at the ends, then forming a swelling curve, which keeps within the margin, and passes down to the nodule, where it appears to be fixed; central portion with point longitudinal lines; striæ obscure. Length .0050". (Plate IV. fig. 6.)

Hab.—Curteis Straits, Queensland.

Panduriform and lyre-like in its general aspect, partly from its shape, and partly from the peculiar curve of the supplementary wings, and the longitudinal lines of the central portion. In this, as well as in the preceding species, the supplementary wing does not form a single curve as usual, in passing either within or beyond the angle of the constriction, but is itself constricted, and in the present instance very nearly follows the curve of the primary wings as they approach the nodule. I have not been able to resolve the striæ in any part of the frustule.

Amphiprora Meneghiniana, n. sp., Grev.—Front view broadly subrectangular, the ends truncate, wings widely rounded at the corners, with a wide and rather deep constriction; supplementary wings narrow, convex, widely and very slightly concave opposite the nodule; all the wings striate, striæ about 15 in .001". Length .0045". (Plate IV. fig. 7.)

Hab.—Curteis Straits, Queensland.

A very fine strongly margined species, with both primary

and supplementary wings conspicuously striate, the striæ of the former having the appearance of being radiate at the rounded corners. The supplementary wings commence with a curve which, if continued, would carry them beyond the angle of the constriction; but it is soon arrested, and becomes nearly straight, or very slightly concave, and passes just within the line of the nodule. The central portion is marked with a few wide, faint, longitudinal lines.

Amphiprora Brebissoniana, n. sp., Grev.—Front view broadly panduriform, truncate at the ends; wings widely rounded at the corners, and then rapidly inclined in a deep constriction; supplementary wings very narrow, widely, and slightly concave opposite the nodule, striæ conspicuous only in the supplementary wings, about 22 in $\cdot 001''$. Length $\cdot 0035''$. (Plate IV. fig. 8.)

Not very dissimilar in general appearance to the preceding, but marked nevertheless by the shorter frustule, and more abrupt and straight outline of the wing between the rounded corner and the constriction. A closer examination brings out the apparent absence of striæ in the primary wing, and considerably more numerous striæ in the much narrower supplementary wing. The central portion has a few faint longitudinal lines.

Amphiprora rectangularis, n. sp., Grev.—Front view rectangular, the ends very slightly rounded; wings with the sides nearly straight, slightly constricted; supplementary wings convex, overlapping the primary ones only at the notch-like constriction; striæ very fine. Length $\cdot 0035''$. (Plate IV. fig. 10.)

Hab.—Woodlark Island, in a dredging communicated by Dr Roberts of Sydney.

This approaches near to *A. pusilla* of Gregory (*Trans. Roy. Soc. Edin.*, vol. xxi., Pl. IV., fig. 56); but after examination, I am satisfied that it is distinct. It is considerably larger and more robust. The supplementary wings are stronger, and form a flattened curve, becoming parallel with the straight sides of the primary ones, and consequently only overlapping the notch which constitutes the constriction.

Amphiprora? Rabenhorstiana, n. sp., Grev.—Front view

elongated-oblong; the wings converging towards the shortly truncated ends, gradually constricted in the middle, and edged with a border of exceedingly short striæ, 16 in $\cdot 001''$, no supplementary wing apparent. Length $\cdot 0055''$. (Plate IV. fig. 12.)

Hab.—Curteis Straits, Queensland.

I feel so much uncertainty regarding this diatom, that its present position must be held as merely provisional. The general contour is as if it were composed of two broadly elliptical lobes. The coarse striæ are so very short, that they form a mere edging, but showing at the same time a radiating direction.

Amphiprora Jolisiana, n. sp., Grev.—Front view oblong, with perfectly rounded ends and gently constricted sides; wing resembling a narrow border, with a middle row of puncta; central portion oblong, with an apparently prominent edge, and marked with a few faint longitudinal lines. Length $\cdot 0032''$. (Plate IV. fig. 11.)

Hab.—Curteis Straits, Queensland.

A beautiful and distinct little species, without any evident supplementary wing. The puncta are conspicuous, seven or eight in $\cdot 001''$; but I cannot see any striæ.

NAVICULA.

Navicula diversa, n. sp., Grev.—Oblong, slightly constricted at the middle, the lobes ovate-elliptical, obtuse at the ends; striæ moniliform, interrupted by a transverse bar composed of two elongated cellules on each side opposite the nodule, where an angular space is also left by the striæ receding from the median line towards the constriction. Length about $\cdot 0025''$. (Plate IV. fig. 14.)

Hab.—Curteis Straits, Queensland.

The most characteristic feature in this small species is the transverse bar, which shows an interruption of the striæ extending to the margin. This bar is composed on each side of the nodule of two unequal cellules, the one next the nodule being much more elongated than the other. The true median line is very fine, while the extra ones are strongly marked; striæ conspicuously moniliform, 12 in $\cdot 001''$.

STAURONEIS.

Stauroneis Australis, n. sp., Grev.—Elliptical-oblong, bluntly apiculate; striæ not reaching the median line, 22 in $\cdot 001''$; stauros very short and narrow, but well-defined. Length $\cdot 0047''$. (Plate IV. fig. 13.)

Hab.—Harvey Bay, Queensland, in a dredging sent by Dr Roberts.

A rare species, and sufficiently distinguished by the exceedingly short, narrow, and sharply defined stauros.

DESCRIPTION OF PLATE IV.

- Fig. 15. *Grammatophora pusilla*, . . . front view.
 1. *Amphora magnifica*.
 2. „ *pulchra*.
 3. „ *undulata*.
 4. „ *flexuosa*.
 5. „ *sinuata*.
 9. *Amphiprora Thwaitesiana*, . . front view.
 6. „ *Kütsingiana*, . . front view.
 7. „ *Meneghiniana*, . . front view.
 8. „ *Brebissoniana*, . . front view.
 10. „ *rectangularis*, . . front view.
 12. „ *Rabenhorstiana*, . . front view.
 11. „ *Jolisiana*, . . front view.
 14. *Navicula diversa*, . . side view.
 13. *Stauroneis Australis*, . . side view.

All the figures are $\times 400$ diameters.

The Bee-hive British Dwellings at Bosphrennis and Chapel Euny, near Penzance. By R. EDMONDS, Esq., Plymouth.*

The recently discovered “Bee-hive Hut” at Bosphrennis in Zennor which attracted so much attention at the Truro meeting of the Cambrian Archæological Association in August last is described in last month’s *Archæologia Cambrensis* (pp. 120–129) by our Cambrian friend, E. L. B. He thinks, however, that “no similar remains in the same

* Read at the Annual Meeting of the Royal Institution of Cornwall, on the 29th of May 1863.

perfect state are known in Cornwall." But in the Reports of this Institution for 1857 and 1858, and also in my published account of the *Landsend District* (p. 52), I have noticed a similar and probably a more perfect one five miles S.S.W. of it, which I accidentally met with at Chapel Euny, in Sancreed, and which I called a "Bee-hive cave," because it was originally, with the exception of its entrance, buried beneath thick turf. I suspect this was the case also with the bee-hive dwelling at Bosphrennis, and that the opening described as "the small window" was made merely for ventilation. The two dwellings resemble one another in most respects so closely that I see no reason why they should not have been likewise both *caves* with their entrances concealed by furze or other evergreens, like the well-known longitudinal cave at Boleit in St Buryan. In fact, the little that remains of the roof at Bosphrennis is still covered with turf.

It appears to me that in the Landsend District isolated British dwellings, having no central areas open to the sky, were, with the exception of their concealed entrances, generally buried beneath heaps of earth or stones, and then covered with turf or growing furze, briers, and thorns, thus appearing externally, if they rose above the level of the adjoining land, as mere natural elevations, the tops or roofs of which were used by their occupants as watchtowers. This I consider to have been the original description of the Bosphrennis dwelling. For when thus buried, it would have been difficult for an enemy either to discover or to destroy it, whereas if it were a mere hut, with walls all exposed as at present, it could have been easily discovered and quickly pulled down. Moreover, such an unprotected dwelling would have been quite out of place in the Landsend district, where the remains of numerous strongly fortified hill castles, cliff castles, and walled towns and villages, indicate a locality that was once continually exposed to hostile incursions. If it be asked, where are the traces of this dwelling having been ever thus buried? I ask in return, where are the traces of the huge mound of earth within which we know that the large Cromlech of West Lanyon in Madron was completely buried until its discovery

in 1790, when the mound was removed for agricultural purposes?

The longitudinal chamber of the cave at Chapel Euny is on a lower level than the bee-hive chamber into which it leads, and is therefore furnished with an external entrance, as in the Irish example referred to at p. 128, whilst the bee-hive chamber is without any external entrance. At Bosphrennis, on the contrary, the bee-hive chamber is the outer-room, and possesses the only external entrance, because that room is apparently (p. 123) on a lower level than the longitudinal one into which it leads. When a cave or hut on sloping ground has only one entrance, that entrance is, no doubt, generally at or near its lowest accessible part, whilst the highest, driest, and inmost part, is used chiefly as a sleeping apartment.

The length of *each* dwelling is in a straight line running nearly north-west and south-east, of which the bee-hive chamber occupies about a dozen feet at the north-west end; the remainder of the length is occupied by the longitudinal chamber, which is only 9 feet at Bosphrennis, but 18 feet at Chapel Euny. I do not call the latter chamber rectangular, because its side-walls are probably nearer each other at the roof than at the base, by reason of the stones overlapping one another. As these walls and roof do not appear to have been ever disturbed, the Penzance Natural History and Antiquarian Society might, for the sake of their being examined and described, well lay out a few pounds in removing the heap within which they are now concealed.

E. L. B.'s paper contains another passage on which antiquarians will differ in opinion. It is this (p. 122):—"Those members who visited the stone-works at Carn Goch, in Caermarthenshire, in 1855, will remember that in the thickness of the walls were discovered low galleries formed by horizontal and vertical slabs, which were thought to have been used for the passage of sheep or goats in leaving or returning within the works. If they were intended for concealed sallyports for the use of the defendants, they could have been passed only on the hands and knees." Borlase considered somewhat similar remains near Penzance (now entirely removed) to have been part of a British vil-

lage, and a like low gallery (5 feet high) within the thickness of the walls, to have been a private entrance into it.* But I have elsewhere† shown that such low narrow galleries or roofed spaces between two parallel walls, especially when those walls are concentric, and enclose an area open to the sky, leaving only one external entrance, were probably sleeping places, divided by transverse walls into separate apartments, all opening into the area—these sleeping-places being buried beneath an annular mound of earth or stones covered with turf, furze, and thorns, except where the apartments opened into the area. A cluster of such dwellings constituted a British village.

P.S.—I saw the Bosphrennis dwelling after the above paper was read, but so transiently, owing to an unexpected fall of rain, that I mention it merely to add, that in going thither I observed, close to the south side of a small meadow called the Vineyard, into which the Bosphrennis residence‡ opens, large portions of the walls of what appeared to me to have been a cluster of British dwellings: and the uncemented stones forming the modern high walls enclosing the meadow were in all probability taken from these dwellings.

Notice of Observations by F. COHN, Breslau, on the Contractile Filaments of the Stamens in Thistles.§ Communicated by Dr ALEXANDER DICKSON.||

The following is the substance of a letter addressed to Professor C. Von Siebold, in which the author details his observations on the contractility in the filaments of the stamens in thistles:—The five anthers cohere, forming a

* Antiquities, p. 273.

† Landsend District, pp. 45, 47.

‡ The villagers of Bosphrennis would laugh at this being called a *residence*, although in its day it was doubtless no mean habitation. *They* call it a *crow*, which is a Cornish word (pronounced like *crow* in *crowd*) signifying a “pig-gery.”

§ Ueber die contractilen Staubfäden der Disteln. Ein Sendschreiben von Ferdinand Cohn in Breslau an C. v. Siebold. Siebold and Kölliker's *Zeitschrift für Wissenschaft. Zoologie*, XII. p. 366.

|| Read before the Botanical Society of Edinburgh, 9th April 1863.

tube. At the time of flowering, this tube is shut in at the top, and encloses the style. About this period the anther-tube rises to about 4 millimeters above the extreme points of the corolla; and if the same is touched, pollen in lumps issues from its summit, the anther-tube at the same time undergoing a remarkable twisting. After an interval—say five minutes—the experiment may be repeated: pollen issues anew from the anther-tube, and twisting movements are executed as before. The style gradually becomes elevated above the summit of the anther-tube, and by the time it projects about 4–5 millimeters beyond, the irritability has completely disappeared. At this time the style becomes fitted for fertilisation, since the two branches of the stigma now first diverge from one another. In general, a period of at most twenty-four hours, often less, elapses between the commencement and cessation of the irritability. When the styles are visible, it is too late for instituting experiments.

These phenomena are produced solely by the contraction of the filaments of the stamens, which, on each touch, instantly contract, and after a little resume their former length. The expulsion of pollen depends upon the anther-tube being drawn downwards upon the style by the contracting filaments, and then pushed up again. The contractility of the filaments is most interestingly shown, if the stamens are cut away from the corolla. In such a preparation there is the anther-tube with the five filaments depending therefrom; and these latter, on every touch, exhibit the liveliest irritability,—throw themselves backwards, straighten themselves again, bend to the opposite side, and wind round one another. One might fancy that it was a *Hydra*, rather than a vegetable organism. These motions had been previously described by Cohn himself in 1861, and subsequently by Kabsch (1861), and Unger (1862).

This contraction may be induced by electrical stimulus. Weak currents produce immediate contraction of the filaments, which, however, extend themselves after an interval. Strong currents, on the other hand, kill them at once; and in consequence of this, the contracted filaments never extend themselves again, but become further short-

ened, so that after about an hour they are shortened by about one-half.

Other means of death—as soaking in alcohol, glycerine, or even water—produce a like result; showing that shrinking by evaporation cannot be the cause of the shortening. By death the filaments are contracted to their minimum length. The ultimate projection of the style to about 5 millimeters beyond the anther-tube depends mainly upon the shortening of the filaments in dying. By this shortening, the anther-tube is at last about $\frac{1}{2}$ –1 millimeter below the corolla-points; while a few hours before it extended 3–4 millimeters beyond them.

The filament consists of a central bundle of annular and closely-wound spiral vessels, surrounded by longitudinal rows of long cylindrical cells with straight partition walls. Externally it is covered by an epidermis of similarly shaped cells, but which are more thickened and convex on their free surface, so that the filament appears uniformly channelled. From the surface project peculiar conical hairs, each consisting of two flat cells applied to one another; these, as well as the epidermis cells, are covered by a pretty thick *cuticula*. When the contractile filament is elongated, the inner cells, seen in longitudinal section or otherwise, appear *longitudinally striated*, “as if they were provided with longitudinal fibres.”

The contracted state of the cells is best seen when the anther-tube has come to be below the level of the corolla-points. By this time the cells of the filaments are all dead, as is proved by the shrunken primordial utricles. The cells are now all closely cross-striped—to appearance, as if the filament consisted of a number of spiral vessels. In those places where especially shorter cells occur, there is the closest transverse striation—almost like that of striped muscular fibre. This striation is caused by a very regular and close transverse corrugation of the cells, in the contraction of the filament; hence the side-walls of the cells appear finely and closely wrinkled, so that 10–20 cross folds occur in every $\frac{1}{30}$ of a millimeter. This corrugation affects all the cells,—including those of the epidermis,—except some in the centre near the air canals, whose cells often remain

unwrinkled. The process of contraction may be followed directly under the microscope, since water, or glycerine, kills the cells sooner or later. The edges of the cells are seen to become wavy. After a little, the cross-stripping is everywhere evident. Almost instantaneously the extreme contraction of the filament occurs, and at the same time the closest corrugation of its cells.

Although unable to follow the action of a *temporary* stimulus under the microscope (since the filaments soaked in water to render them transparent do not again extend themselves), the author expresses his conviction that the *momentary* shortening of the filament by stimulus, equally with the *permanent* contraction in death, depends upon a transverse corrugation of the cells. The filaments in shortening become thicker; the following are measurements of breadth *before* and *after* stimulation:—

Before,	$\frac{94}{1000}'''$	After,	$\frac{115}{1000}'''$
"	$\frac{106}{1000}'''$	"	$\frac{119}{1000}'''$
"	$\frac{116}{1000}'''$	"	$\frac{127}{1000}'''$

From the circumstance that contraction ensues upon death equally as upon a temporary stimulus, the author is induced to believe that the cells of the elongated filament are in a state of active expansion, while the contracted condition depends upon a relaxation, in consequence of which the *elasticity* to which the expansive force was opposed now comes into play. This elasticity appears to reside chiefly in the very thick cuticula, which does not, even in the most contracted filament, exhibit any corrugation, thus showing itself to be highly elastic.

The author believes that at least in the lowest animals (which possess, not muscles, but a contractile parenchyma) the same conditions hold as in contractile vegetable cells. In these animals occurs the same momentary contraction by stimulus, and the permanent and utmost contraction in death, apparently in consequence of the elasticity of their cuticula; whilst their elongation and extension is a vital and active process. For example, the stalks of the Vorticellas become rolled up equally upon stimulation as upon

death. Further, in *Amœba*, *Actinophrys*, *Diffugia*, *Arcella*, and the *Rhizopoda* generally, the processes are manifestly *actively* elongated, while these organisms, by stimulus as by death, are contracted into globules. Similar phenomena are exhibited by *Hydra viridis*, &c. In all these organisms there is a permanent contraction in death, which yields only to diffuence of the body by decomposition. There is no final relaxation, as in true muscular tissue.

The author gives some figures representing the microscopic appearances of the cells of the filament in the expanded and contracted conditions, but which it is unnecessary to reproduce here.*

On Muscular Power. By H. F. BAXTER, Esq.

§ 1. *On the Mechanical Power of Muscles exerted during Muscular Contraction.* § 2. *On the Application of the Principle of Conservation of Force or Conservation of Energy to the explanation of Physiological Phenomena.*

That muscular contraction is accompanied with the development of *electrical action*, I have already shown on a former occasion,† thus confirming the results previously obtained by Matteucci and Du Bois Reymond. That *heat* is evolved during muscular contraction, has been shown by Breschet and Becquerel,‡ and by Matteucci.§ That changes of a *chemical* nature take place in muscles, in consequence of muscular action, has been established by the experiments of Liebig, Helmholtz, and others; and Matteucci|| has ascertained that, during muscular contraction, carbonic

* There appears to be some mistake in the representation of the section in fig. *d* (*l. c.* p. 369): it purports to be a transverse section of the filament, and the more or less hexagonal outline of the cells would bear out the assertion; yet I do not understand how *transverse* corrugation could appear in a transverse section at all in the way represented in the figure, almost like the edge of a close frill.—A. D.

† Philosophical Magazine, 1855. Essay on Organic Polarity, 1860.

‡ Traité de l'Electricité, tom. iv. p. 9.

§ Annales de Chimie et de Physique. Juin, 1856.

|| Ibid.

acid is evolved. Here, then, we have the fact established, that during muscular action the three forces, *heat*, *electricity*, and *chemical* action are manifested; but the most important function connected with muscular action, and which remains to be considered, is undoubtedly its mechanical power; and just as the mechanical philosopher endeavours to solve the problems respecting the mechanical power of his machinery, so may the physiologist attempt the solution of similar questions respecting the mechanical power of the animal body; and the question may be thus put,—*What is the mechanical equivalent of muscular power exerted during muscular contraction?*

§ 1. *On the Mechanical Power of Muscles exerted during Muscular Contraction.*

Matteucci,* in a series of experiments undertaken for the purpose of solving this question, says, “Avec un poids de 100 grammes attaché à un gastrocnémien, qui pèse à peu près 0·320^{gr} et qu’on fait contracter, le poids est soulevé à une hauteur de 0·84^{mm}.; avec un poids de 70 grammes, cette hauteur est de 1·130^{mm}.; avec 40 grammes, de 1·270^{mm}.; et avec 10 grammes, la hauteur est de 1·412^{mm}.” He adds, “M. Helmholtz, qui employait un poids de 180 grammes, a obtenu une élévation qui a varié dans une série d’expériences successives, de 0·88^{mm}. à 0·65^{mm}.”

“J’adopterai donc,” continues Matteucci, “pour déterminer le travail mécanique d’une contraction d’un gastrocnémien qui soulève un poids de 10 grammes, et son propre poids qui est 0·320^{gr}, la hauteur de 1·412^{mm}. ce qui donne pour le travail mécanique d’une contraction 0·00001457 kilogrammètres.” The fact that Helmholtz obtained similar results, although he employed a much heavier weight, did not escape Matteucci’s notice, and he says, “Malheureusement pour le but de mon recherche, M. Helmholtz a fait l’expérience avec un poids de 180 grammes attaché au gastrocnémien, et qui était soulevé par la contraction; or il est très-facile de prouver, et c’est, je crois, M. Schwann qui l’a fait le premier que le travail mécanique d’une contrac-

* Annales de Chimie et de Physique. Juin, 1856.

tion augmente dans certaines limites avec le poids attaché au muscle, et qui est ainsi soulevé ce qui nécessairement fatigue et détruit beaucoup plus rapidement la force du muscle."

Professor Haughton of Dublin has recently investigated the question in the human subject, and has arrived at the conclusion, "that 1 lb. weight of a muscle is capable of lifting 1.56 ton through one foot before it became exhausted."*

Astounding as these results may appear, it is not for physiologists to ignore them. The circumstance that a great difference exists between one human individual and another in regard to their muscular powers, makes it difficult to suppose that the same results would be obtained in every case. Professor Haughton himself has shown that age has great influence respecting the time in which a muscle becomes exhausted. The question however occurs, are we enabled to ascertain the muscular power of an animal by its total weight, or are we obliged to ascertain by experiment the power of each individual separately.

In the following experiments, instead of employing the gastrocnemius muscle of the frog separated from the animal, as was done by Matteucci and Helmholtz, I adopted the plan pursued by Schwann in his investigations on muscular contraction, viz., the limb remained connected with the animal, so that the vital conditions of the muscle should be maintained during the experiment; wishing also to have the animal as perfect as possible, in my first experiments the sciatic nerve was merely exposed, but not divided, and the muscle made to contract by stimulating it; but from the frequent and general struggles of the animal, together with the contraction excited in other muscles by reflex action, this mode was soon abandoned, and the sciatic nerve divided. With the sciatic nerve divided, struggles on the part of the animal will occasionally occur; and although the gastrocnemius muscle itself is not contracted, still the animal can elevate the limb, and raise the weight, but this effect can be readily discriminated from that due to the

* Outlines of a New Theory of Muscular Action. Dublin, 1863.

contraction of the gastrocnemius alone. The importance of confining the contraction solely to this muscle, as observed by Matteucci, the perineal nerve was divided, so as to avoid the contraction of the extensor muscles; this could be readily done, as the sciatic nerve is seen to divide into two large branches at the lower part of the thigh. Care, however, must be taken that the posterior branch be not divided; to ascertain this point, the nerve was stimulated after the division, to see which muscles were contracted. Instead of keeping the frog in the horizontal position, according to the method pursued by Schwann, I found the following to be the most convenient and satisfactory mode of conducting the experiments:—

The apparatus made use of was similar in principle to that employed and described by Matteucci in the *Phil. Trans.* for 1846, and to which I must refer. It consists of a glass stem fixed upon a wooden stand; to this stem could be adjusted and fastened, by means of screws, several moveable pieces; to the lower one the pulley was attached, and the scale upon the dial was divided into 80° . The circumference of the pulley was $1\frac{1}{2}$ inch, consequently 1° of the scale corresponded to rather more than $\frac{1}{83}$ d of an inch. The next piece above the pulley consisted of the portion fork-shaped, and through the holes at its extremities the silk passed, to prevent it from slipping off the pulley: to the upper end of the silk was tied a small hook; to its lowest end the scale was attached which carried the weight. The two upper detached pieces were for the purpose of securing the frog; on the lower one, which projected horizontally forwards, the frog was placed astride, one limb being attached to the pulley, the other limb was tied at the ankle, and fastened, by means of a string, to one of the arms of the lower piece which supported the dial; by these means the two limbs were balanced when the weights were placed in the scale. To the upper detached piece, which projected horizontally outwards at right angles to the lower one, the fore-extremities of the animal were fastened by strings. By this arrangement the frog was firmly fixed without interfering with its breathing, and there was no impediment to the free circulation of the blood in the lower limbs.

In my preliminary experiments I first took the weight of the frog, but soon found that during its preparation it frequently ejected a quantity of fluid, amounting to 10 or 15 grains, or more ; in subsequent experiments it was prepared in the following manner:—The tendo-Achillis was exposed by removing a portion of skin ; a piece of strong silk was then passed beneath it by means of a needle, and tied on to the tendon, so as to form a loop to which the hook connected with the pulley could be attached. A portion of skin of the thigh, over the course of the sciatic nerve, was removed, and the ligatures tied on to the fore-extremities, and to the hind limb. The animal was then secured in a screw of paper and weighed ; the weight of the strings and paper were subsequently deducted from the total weight. The sciatic nerve was then exposed and divided, and the frog fastened on to the apparatus.

To excite the nerve, and in order to have a constant power, not possessing a rheostat, one of Smee's middling sized cells, with amalgamated zinc plates, was used. The acid employed consisted of dilute nitro-sulphuric acid (1 acid 40 water). A thick copper wire was connected with the platinode, the free extremity of which passed through a piece of cork and was bent at right angles to the extent of half an inch, so as to press down upon its surface ; between the cork and the wire was a piece of coarse bibulous paper, and which was folded over the extremity of the wire ; the paper was kept moistened, and upon it the nerve rested. The wire connected with the zincode was not so thick, and its central portion wound round in the form of a helix, by the elasticity thus given to it its extremity could be readily applied to the tendo-Achillis without moving the cell, and facilitated the making and breaking of contact. The current was always used as the *direct* form, *i.e.*, it traversed the nerve and muscle to the tendo-Achillis.

The *precautions* to be observed are numerous.

1. *Avoid the loss of Blood.* Having carefully laid bare the sciatic nerve in the upper part of the thigh with a blunt pointed probe, it was withdrawn and divided ; but instead of exposing the nerve throughout its whole course by separating the muscles, it was again carefully dissected out at

the lower part of the thigh and drawn down, by these means the risk of wounding or lacerating the vessels crossing the nerve in the middle of the thigh was avoided.

In tying the tendo-Achillis to form the loop, unless care be taken, the vessel running along its inner border will be wounded when passing the needle.

2. *Not to tie the Muscular Fibres.* If, in tying the tendo-Achillis, the loop be carried too high up, the muscular fibres will be included; in this case they soon become lacerated and torn through, when the weights are added to the scale.

3. *To keep the Sciatic Nerve away from the surface of the Thigh.* It frequently happened that during the struggles of the animal the sciatic nerve would come into contact with the surface of the thigh, although its extremity was resting on the bibulous paper. Under these circumstances contractions may not be excited in the muscles when the current is passed, and this I believe to be due to the current instead of being transmitted along the nerve, *through* the muscle, was thus transmitted by the surface of the muscle or the skin of the thigh. The nerve should be kept straight away from the thigh.

4. *The Electrodes should be clean.* This is a most important circumstance to be attended to, especially with the electrode employed to touch the surface of the tendon. When the electrode is brought into contact with the surface of the tendon it becomes covered with the fluid, and a crust is soon formed upon it which acts as a non-conductor; to remedy this, it is necessary to frequently scrape it, so as to present a fresh and clean surface; mere wiping is not sufficient. The surface of the wire in contact with the bibulous paper should be carefully looked to and frequently scraped, and the paper upon which the nerve rests be kept moist, and the nerve itself occasionally slightly moistened.

5. When exciting the muscles to contract, the tendo-Achillis should be touched *lightly* and *quickly*. If the electrode be allowed to remain too long in contact with the tendon, we have two contractions, one on *making*, the other on *breaking*, contact. If the tendon be struck too forcibly the muscle will be thrown out of its perpendicular position, and thus elevate the weight and move the index.

There are other precautions necessary to be observed, which will be better understood after detailing some of the experiments.

It would have been far more satisfactory to have detailed the observations made upon each individual frog; but as this would occupy too much space, including sixty experiments, I have thought it better to tabulate the results and give the particulars of one experiment, and describe the mode of proceeding in each.

The weight (Troy weight) was first ascertained, and the frog then arranged for the experiments. The index having been pushed back as far as it could be, the degree at which it stood was noted; a weight was then put into the scale, and the index then carried back and the degree noted—this gave the elongation produced by the weight. The muscle was then made to contract, the degree noted, and the index pushed back; the muscle was again made to contract, the degree noted, and the index pushed back; this was done three times consecutively: the weight removed, and the degree to which the index returned noted. Half a minute was allowed to elapse; the electrode was cleaned and scraped, and another weight was then added to the scale, when similar observations were made. I could make the three observations, and record them, in twelve seconds; but with an assistant to record them it took about five seconds. To render the description clearer, I will give the details of one experiment.

July 14. Weight of frog 3 drs.
54 grs., caught yesterday afternoon.

Index 52.

4 oz.	39	40
	39	40
	38½	39½

Index 45.

6 oz.	35	35½
	34½	35
	34	34½

Index 43.

4 oz.	36	37
	36	37
	36	37

Struggles of the animal carried the scale without the weight to 85°.

Index 44.

5 oz.	34	34¾
	34	34¾
	33½	34½

Index 41½.

4 oz.	35	36
	35	36
	35	36

Index 41.

3 oz.	35	36½
	35	36½
	35	36½

Index 45.

5½ oz.	33	33½
	32	32½
	32	32½

Index 40.

4½ oz.	32	32½
	32	32½
	32	32½

Index 38.

3½ oz.	32	32¾
	32	32¾
	32	32¾

Struggles carried scale without weight to 92°.

Index 41.

3 oz.	33	34
	33	34
	33	34

Index 39.

6 oz.	30,	the index just moves
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Index 37.

5 oz.	30	30¼
	30	30¼
	29½	29¾

Index 35.

4 oz.	29	29½
	29	29¾
	29	29¾

Struggles carried scale to 92°.

Index 38.

3 oz.	31	32
	31	32
	31½	32½

Index 35.

5 oz.	29	29½
	29	29½
	28	28½

Struggles carried scale to 80°.

Index 38.

4 oz.	29	30
	29	30
	29	30

Struggles carried scale to 90°.

Index 38.

3 oz.	30	31½
	30	31½
	30½	31½

Index 35.

2 oz.	31	33
	31	33
	32	33

Struggles carried scale to 80°.

Index 38.

4½ oz.	29	29¾
	29	29¾
	28½	29¼

Index 35.

3½ oz.	29	30
	29	30
	29	30

Index 36.

The experiment was discontinued for a quarter of an hour, during which time struggles had taken place carrying the index as far as it could. The index was now brought back to 40°.

4 oz.	29	30
	28½	29½
	28½	29½

Index 36.

3 oz.	29	30½
	29	30½
	29½	30½

Index 37.

5 oz.	28½	29
	28	28½
	28	28½

The animal was now removed, and its weight found to be 3 drs. 47 grs.

The gastrocnemius of the leg submitted to experiment was somewhat darker and heavier than the other; the slight difference just turned the scale of the balance. The weight of each 3 grs.—Sex, M.

After each experiment the plates were removed from the cell of the battery and rinsed in clean water.

Judging from the results obtained in this experiment, I consider that the normal power of the gastrocnemius muscle of this frog was capable of raising 4 oz. (to which must be added 2 drs. for the weight of the scale) 1° , or $\frac{1}{3}$ d part of an inch.

As the mode in which the weights are added have great influence over the results, it is necessary to be acquainted with it. If the weight be rather heavy in the first instance, the elongation of the muscle takes place gradually and continuously, and unless the index be carried sufficiently back before the muscle is made to contract, the full amount of contraction will not be obtained; and if the weight be too heavy for the muscle, it acts by exhausting the muscular power or by overstretching the muscle. If the weight be not sufficiently heavy to elongate the muscle, the amount of contraction is not greater than with a heavier weight, proving the correctness of the conclusion arrived at by Schwann, that the contractile power of a muscle is greater the more it is elongated. There is a limit to the natural elongation of a muscle, and this limit it is somewhat difficult to ascertain. It is not indicated by gradually adding the weights to the scale until contraction is just excited, but more by the permanency and constancy of the results when the experiment is repeated. The criterion which I think may be acted upon with safety is this—commence with a medium weight, and note the results obtained by increasing the weight; if the muscle continues to elongate, and if the index has a tendency to recede, we are getting beyond the limit of its natural elongation. If by diminishing the weight the index has a tendency to advance or to retain its position, we have now obtained some indication of its natural power. In the experiment detailed I began with a medium weight,—4 oz.,—and the index was brought to 39; 6 oz. were afterwards added, this brought it to 35, and during the contraction it fell to 34; 4 oz. were then added, it arose from 35 to 36, and retained that number. If we cast our eye over the results, we find that the heavy weight evidently exhausted the power of the muscle, and

that during the time the muscle contracted there was a tendency on its part to become further elongated. When a lighter weight was substituted the tendency was to contract, and the degree of contraction of the muscle when excited was not increased in proportion. I may just observe, that the motion of the index is not always as if by a sudden action, but by a gradual advance, being carried along, as it were, by some progressive movement.

There is another circumstance to be noticed, the weights raised do not indicate a fractional part less than the half ounce. I will not go so far as to say that a less weight than this might not be measured, but I have found that by adding the half ounce the effects were very doubtful. The best plan to elucidate the result was not by adding or subtracting the half ounce from the previous weight, but to go through a series of weights increasing or diminishing by the ounce; for instance, begin with 3, then 4, and then 5; in the next series begin with $3\frac{1}{2}$, then $4\frac{1}{2}$, and then $5\frac{1}{2}$. By this means the effect of the half ounce could be more readily seen than by adding it to the ounce. The addition of a drachm was not perceptible.

The utmost care was taken to obtain the exact weight of the gastrocnemius muscle immediately after each experiment.

The frogs were fresh caught, and if not used on the same day, were kept in a dark, cool cellar during the night, and used on the following day.

In Table I. will be found the results of 60 experiments, arranged according to the date when they were performed. The sum total shows that 4 drs. 22 grs. weight of muscle were capable of raising a weight equivalent to 332 oz.; in other words, 1 gr. of muscle could raise, in round numbers, 608 grs. through the space of 1° , which was equivalent to $\frac{1}{83}$ of an inch; the extremes were 1048 (Expt. 51) and 520 (Expt. 24). The weight of the frogs before the experiments was 34 oz. 4 drs. 18 grs.; after the experiments 33 oz. 3 drs. 26 grs., indicating a loss of 1 oz. 52 grs. Out of the 60 frogs 26 were females; and in order to ascertain the sex no external character was trusted to, but the body was examined after the experiment.

TABLE I.

No. of Experiment.	Date when performed.	Weight of Frog before Experiment.		Weight raised.	Weight of Frog after Experiment.		Weight of Muscle.	Sex.	
		drs.	grs.	oz. drs.	drs.	grs.	grs.		
1	June 26	4	25	4 2	4	18	4	M.	{ The muscle which raised the weight heavier by $\frac{1}{4}$ th of a grain, and more vascular.
2	...	8	7	9 2	8	0	8	F.	Heavier by $\frac{1}{2}$ a grain, and more vascular.
3	...	3	45	4 2	3	38	4 $\frac{1}{2}$	F.	Muscle more vascular, but of the same weight.
4	...	3	20	3 6	3	14	2 $\frac{1}{2}$	M.	Slight difference in vascularity; weight the same.
5	...	5	35	7 2	5	28	5 $\frac{1}{2}$	M.	Slight difference in vascularity; weight the same.
6	...	2	55	3 2	2	47	2 $\frac{1}{2}$	M.	{ Muscle presents spots of vascularity; weight the same.
7	...	5	5	5 2	4	55	4 $\frac{3}{4}$	F.	Heavier by $\frac{1}{4}$ th of a grain, and more vascular.
8	...	5	55	6 6	5	47	5	M.	Slight difference in vascularity; weight the same.
9	July 1	2	0	2 6	1	55	1 $\frac{1}{2}$	M.	No difference in colour or weight.
10	...	2	8	3 2	2	3	1 $\frac{3}{4}$	F.	No difference in colour or weight.
11	...	2	7	2 6	2	0	1 $\frac{1}{2}$	M.	No difference in colour or weight.
12	...	2	38	3 2	2	33	2	M.	Slight difference in colour; same weight.
13	...	4	50	4 2	4	42	3	M.	No difference in colour or weight.
14	...	5	55	7 6	5	46	6	F.	{ No difference in weight or colour. This appears to be an old frog; the thigh bone of the limb not experimented upon was fractured during the struggles of the animal; muscles red.
15	...	1	50	2 2	1	44	1 $\frac{1}{2}$	M.	No difference in weight or colour.
16	...	2	48	3 2	2	41	2	M.	{ Muscle apparently ecchymosed; no difference in weight.
17	...	2	56	3 6	2	48	2 $\frac{1}{2}$	M.	{ Muscles of both limbs apparently ecchymosed; no difference in weight.
18	...	5	12	7 2	5	1	5 $\frac{1}{2}$	F.	Heavier by $\frac{1}{4}$ th of a grain, and more vascular.
19	...	8	0	9 2	7	46	7 $\frac{1}{2}$	F.	No difference in colour or weight.
20	...	8	57	9 6	8	45	9	F.	No difference in weight; slightly darker.
21	...	9	0	10 2	8	48	8 $\frac{1}{2}$	F.	Heavier by $\frac{1}{2}$ a grain; no difference in colour.
22	...	4	45	5 6	4	36	4	M.	Slight difference in colour; heavier by $\frac{1}{2}$ a grain.
23	...	5	30	6 2	5	21	5 $\frac{1}{2}$	F.	No difference in colour; slightly heavier.
24	...	8	35	10 2	8	21	9 $\frac{1}{2}$	F.	Heavier by $\frac{1}{2}$ a grain, and more vascular.
25	...	6	53	8 6	6	41	7	M.	{ No difference in colour; just turned the scale of the balance.
26	...	9	10	9 2	7	55	8 $\frac{1}{2}$	F.	{ Slight difference in colour and weight. Fluid ejected during the experiment.
27	...	2	53	4 2	2	48	2 $\frac{1}{2}$	M.	No difference.
28	...	5	51	6 6	5	44	5	F.	No difference.
29	...	5	49	6 2	5	40	5 $\frac{1}{4}$	M.	{ Slightly darker and heavier. Tetanic contractions when weight was removed, but subsided upon moistening the nerve.
30	...	4	10	4 2	4	1	3 $\frac{1}{2}$	M.	No difference.
31	...	2	13	3 2	2	8	2	M.	Somewhat darker, but of same weight.
32	...	2	10	3 2	2	6	2	F.	No difference.
33	...	2	20	3 6	2	12	2	M.	No difference.
34	...	3	0	3 6	2	55	3 $\frac{1}{2}$	F.	No difference.
35	...	2	15	2 6	2	8	2	F.	No difference.
36	...	3	8	4 2	2	58	3 $\frac{1}{2}$	M.	Slightly darker and heavier.
37	...	2	56	4 2	2	47	2 $\frac{3}{4}$	F.	No difference.
38	...	2	40	3 6	2	34	2	F.	Slightly heavier.
39	...	3	0	4 2	2	55	3	M.	No difference.
40	...	2	48	4 2	2	43	3	M.	No difference.
41	...	8	25	9 6	8	17	8	F.	No difference.
42	...	5	36	8 6	5	25	7	M.	No difference.
43	...	4	0	5 2	3	53	3 $\frac{1}{2}$	F.	Darker, but weight the same.
44	...	4	28	6 2	4	17	4 $\frac{1}{2}$	M.	Darker, and slightly heavier.
45	...	2	22	3 2	2	15	2	M.	No difference.
46	...	7	5	8 2	6	58	8	F.	No difference.
47	...	3	50	4 2	3	45	3 $\frac{1}{2}$	M.	No difference.
48	...	3	54	4 2	3	47	3	M.	Slightly darker.
49	...	3	52	4 2	3	43	3 $\frac{1}{2}$	M.	Darker; no difference in weight.
50	...	2	28	3 6	2	23	2	M.	Slightly darker.
51	...	2	5	3 6	2	0	1 $\frac{3}{4}$	M.	No difference.
52	...	6	20	5 2	6	15	5	F.	No difference.
53	...	4	38	5 2	4	33	5	M.	Darker coloured, and slightly heavier.
54	...	7	20	10 2	7	12	9	F.	{ Slightly heavier. Tetanic contractions when the weight was removed, which did not subside upon moistening the nerve.
55	...	2	32	3 2	2	26	2	F.	Darker coloured; same weight.
56	...	5	58	6 6	5	50	6	M.	Slight difference in colour; same weight.
57	...	4	48	5 2	4	42	4 $\frac{1}{2}$	M.	Darker, and heavier by $\frac{1}{4}$ th of a grain.
58	...	6	52	8 6	6	40	7 $\frac{1}{2}$	M.	Darker, but of same weight.
59	...	4	13	3 2	4	8	3 $\frac{1}{2}$	F.	No difference.
60	...	7	58	9 2	7	45	8	F.	Slight difference in colour; same weight.
Total,		oz. drs. grs.		oz.	oz. drs. grs.		drs. grs.		
		34 4 18		332	33 3 26		4 22		

TABLE II.

MALES.							FEMALES.						
Weight of Muscle.	Weight raised.	Weight of Frog before Experiment.		Weight of Frog after Experiment.		No. of Experiment.	Weight of Muscle.	Weight raised.	Weight of Frog before Experiment.		Weight of Frog after Experiment.		No. of Experiment.
grs.	oz. drs.	drs.	grs.	drs.	grs.		grs.	oz. drs.	drs.	grs.	drs.	grs.	
1½	2 2	1	50	1	44	15	1½	3 2	2	8	2	3	10
1½	2 6	2	0	1	55	9	2	2 6	2	15	2	8	35
1½	2 6	2	7	2	0	11	2	3 2	2	10	2	6	32
1½	3 6	2	5	2	0	51	2	3 2	2	32	2	26	55
2	3 2	2	13	2	8	31	2	3 6	2	40	2	34	38
2	3 2	2	22	2	15	45	2½	4 2	2	56	2	47	37
2	3 2	2	48	2	41	16	3½	3 2	4	13	4	8	59
2	3 6	2	20	2	12	33	3½	3 6	3	0	2	55	34
2	3 6	2	28	2	23	50	3½	5 2	4	0	3	53	43
2½	4 2	2	53	2	48	27	4½	4 2	3	45	3	38	3
2½	3 6	3	20	3	14	4	4½	5 2	5	5	4	55	7
3	4 2	2	48	2	43	40	5	5 2	6	20	6	15	52
3	4 2	3	0	2	55	39	5	6 6	5	51	5	44	28
3	4 2	3	54	3	47	48	5½	6 2	5	30	5	21	23
3	4 2	4	50	4	42	13	5½	7 2	5	12	5	1	18
3½	4 2	3	50	3	45	47	6	7 6	5	55	5	46	14
3½	4 2	4	10	4	1	30	7½	9 2	8	0	7	46	19
4	4 2	4	25	4	18	1	8	8 2	7	5	6	58	46
4	5 6	4	45	4	36	22	8	9 2	8	7	8	0	2
4½	5 2	4	48	4	42	57	8	9 2	7	58	7	45	60
5	5 2	4	38	4	33	53	8	9 6	8	25	8	17	41
5	6 6	5	55	5	47	8	8½	9 2	9	10	7	55	26
5½	7 2	5	35	5	28	5	8½	10 2	9	0	8	48	21
7	8 6	5	36	5	25	42	9	9 6	8	57	8	45	20
7	8 6	6	53	6	41	25	9	10 2	7	20	7	12	54
7½	8 6	6	52	6	40	58	9½	10 2	8	35	8	21	24
dr. grs.	oz.	dr. grs.	grs.	dr. grs.	grs.		dr. grs.	oz.	dr. grs.	grs.	dr. grs.	grs.	
1 30	123	12 2	25	11 7	23		2 22½	171	18 2	9	17 5	27	

In Table II. will be seen the influence of *sex* upon the results, and in order to reduce the number of males to that of the females, and to avoid anything like a selection, every fourth male, as recorded in Table I., was omitted. This Table has also been arranged according to the weights of the gastrocnemius muscles; and it will be seen that the total weight of the female frogs before the experiment was 18 oz. 2 dr. 9 grs., whilst that of the male frogs was only 12 oz. 2 dr. 25 grs. The total weight raised by the female frogs was 171 oz., by the male frogs 123 oz.; but the weight of the gastrocnemius muscles in the females was 2 dr. 22½ grs., that of the males 1 dr. 30 grs., indicating that the muscular power of the males, as compared to that of the females, showed that 1 gr. of muscle in the males could raise 656 grs., whilst in the females 1 gr. raised only 579.

From these experiments we find that the weight of the
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animal is no true indication of its muscular power. They also establish this important fact, that during muscular exertion there is a tendency on the part of the muscle to *increase* in weight and consequently in power. I shall allude to this circumstance again, and will now merely draw the attention of those who consider the animal body as bearing a strong resemblance to a steam-engine, that we have here, in the animal machine, the paradoxical fact of a machine increasing its power whilst doing work. The increased vascularity may be due, in part, to the division of the vaso-motor nerves.

There can be no doubt that *age* would have an important influence over the results; at present I know of no character by which the age of the animal may be ascertained, and consequently unable to obtain any evidence to decide this point satisfactorily.

To show the importance of the healthy condition of the animal, I will draw up in a tabular form the results of a few experiments in which the frogs had been kept without food for three weeks, and in a comparatively warm situation.

TABLE III.

No. of Expt.	Date.	Weight of Frog <i>be- fore</i> Expt.		Weight raised.		Weight of Frog <i>after</i> Expt.		Weight of Muscle.	Sex.
		drs.	grs.	oz.	drs.	drs.	grs.		
1	July 16	3	18	1	0	3	10	23 $\frac{3}{4}$	M.
2	...	2	10	0	6	2	1	2	F.
3	...	4	15	1	2	4	8	31 $\frac{1}{4}$	M.
4	...	7	5	1	6	6	54	8	F.
5	...	6	9	1	2	5	59	71 $\frac{1}{2}$	M.

Table III. will not require any analysis, as the facts will speak for themselves. The frogs were flabby, and the muscles pale and soft.

In the following experiments the limb was separated from the body to ascertain the influence of the circulation of the blood. The spine was divided in the lumbar region, and the whole of the viscera, together with the upper part of the animal, removed, leaving the pelvis and the two lower

extremities, which were fastened to the apparatus as in previous experiments. The results were as follow:— During the first five minutes the muscle could raise the medium weight, provided the contractions were not excited too often. If a heavy weight were put into the scale, the muscle soon became exhausted, and required time to recover itself. If the muscle could elevate the medium weight of 3 oz. 1° at the commencement of the experiment, and if it were made to contract once in a minute, at the end of half an hour this was reduced to 1 ounce. The weight was not kept in the scale the whole time, but removed after every contraction. The contractility of the muscle continued some hours, but the power of the muscle became gradually weaker. In another experiment, the continual suspension of a heavy weight for a quarter of an hour reduced the power of the muscle that it only raised 2 drs. When the weight was removed, tetanic contractions were observed, but upon moistening the nerve they subsided. Tetanic contractions were observed in two of the experiments recorded in Table I., in one (Exp. 29) the effect subsided upon moistening the nerve, in the other (Exp. 54) this had not the desired effect, and they must therefore have been dependent upon other circumstances than the state of the nerve. The importance of maintaining the circulation of the blood in these experiments is very evident. As there was a tendency in the former experiments to an increase in the nutrition of the muscle, I was led to examine whether any increase in its electric condition occurred under these circumstances.

A frog fresh caught, and weighing 4 drs. 25 grs., was taken, and 2 oz. put into the scale; the muscle was made to contract every 10 seconds for a quarter of an hour. The two gastrocnemii were removed as quickly as possible, and examined; the muscle experimented upon indicated 3°, that of the other limb 2°. They were then arranged into a circuit, to ascertain the amount of the differential current; the effect upon the galvanometer amounted to $\frac{1}{2}^{\circ}$ in favour of the former muscle. The elements were then arranged to form a combined current, when the effect upon the needle amounted to 4°. The muscle was more vascular than the other. The experiment was repeated upon another

frog, which weighed 7 drs. 10 grs. With a weight of 4 oz., after the lapse of five minutes, the muscles were examined. The separate muscles indicated the one acted upon 4° , the other 2° . When united to show the differential current, the effect was $1\frac{1}{2}^{\circ}$ in favour of the muscle experimented with; when the elements were arranged to show the combined current, the effect upon the needle was 5° .

In other experiments, four in number, the results always indicated an increase on the part of the muscle experimented with.

Not having the necessary apparatus, I could not investigate the question respecting the *heat* that is developed during muscular contraction.

The following conclusions may be deduced from the foregoing inquiry:—

1st, Out of 60 frogs taken indiscriminately, the average results of the experiments show that 1 grain of muscle is capable of raising a weight of 608 grs. 1° , or through a space of $\frac{1}{3}$ of an inch.

2d, That sex has an important influence over the results. In males it was found that 1 gr. = 656 grs., whilst in females, 1 gr. = 579 grs.

3d, That the weight of the animal previous to the experiment gave no indication as to the real muscular power of the animal that could be relied on.

4th, That during the experiment there was a loss of weight in the animal but an increase of weight in the muscle experimented upon.

5th, That an increased nutrition of the muscle was indicated by its weight, its vascularity, increase in its electrical condition, and by the maintenance of its muscular power.

6th, That circumstances influencing the health of the animal, such as absence of food, temperature, and confinement, have an important influence over the results.

7th, That the maintenance of the circulation of the blood is of the utmost importance in these experiments.

§ 2. *On the Application of the Principle of "Conservation of Force or Energy" to the Explanation of Physiological Phenomena.*

In my concluding remarks, I will make a few observa-

tions regarding the application of the principle of "Conservation Force or Energy" to organic phenomena.

When we find it stated that the principal products of the light of the sun are plants, because plants can only grow with the help of the sun-light; that the heat of the sun is the cause of vegetation upon the earth; or that the mechanical power of a man may be ascertained by calculating the amount of carbonic acid evolved during respiration, in the same manner as we might ascertain the power of a steam-engine by calculating the amount of heat evolved during the combustion of the fuel supplied to generate the steam; as physiologists we cannot help feeling that some doubt must exist in regard to the data upon which such conclusions are based. For my own part, I remember, when pursuing some investigations a few years ago, respecting the development of plants, that, upon placing some plants (beans) in a dark cupboard to vegetate, they grew more rapidly in the dark than when exposed to the light of the sun; they were blanched, and therefore may not, perhaps, be considered as in their natural state, but nevertheless they grew without the influence of the sun-light. It is, I believe, considered to be a well-known fact amongst vegetable physiologists, that sun-light, under certain circumstances, retards rather than promotes vegetation. Although I make these observations, I do not for one moment deny the influence of sun-light or of heat over vegetation, or the importance of estimating and ascertaining the relation that the evolution of carbonic acid in the animal body, during respiration, bears to the muscular power of the individual. It is in the application of these facts where the doubt exists, and not in the correctness of the principle upon which they are based.

Professor Helmholtz,* in a lecture delivered at the Royal Institution, has clearly and beautifully shown in a masterly manner the importance of applying this principle to organic nature. The observations that I shall now make will be

* On the Application of the Law of Conservation of Force to Organic Nature. April 12, 1861. I must also refer to a lecture delivered by Professor Faraday at the same Institution, "On the Conservation of Force."—*Phil. Mag.*, April, 1857.

for the purpose of extending these views, and show the importance of its application in the explanation of physiological phenomena. Before doing so, let us endeavour to get a clear view of the object we have in view. In animal bodies, in man, for example, we have the following forces evolved: nerve force, muscular force, heat, and chemical force—now these forces are developed during growth, and maintained by nutrition. Nerve force and muscular force may be considered as the special properties of their respective tissues, and dependent upon the peculiar compounds (chemical) which form them. These compounds are derived from the blood, which, on its part, is derived from the food, hence we must consider the food as the original source from whence the animal body derives its ultimate power. Heat and light influence the formation of the various compounds which go towards forming and maintaining the animal structures. Heat and light may also be given out and developed during the formation of organic compounds; so that we have heat and light necessary for the *formation* of the organic compounds, and we also have the same forces generated during the *disintegration* of the compounds. It appears to me that a great deal of the misconception and confusion which occurs arises in consequence of not keeping clearly in view the *formative* actions, and the *disintegrating* or *destructive* actions which take place in the animal body. Let us now consider for a moment the animal body as a machine doing work. We have nerve work (comprising mental work and nervous action in general) in which nerve force is exhausted; we have muscular work (comprising muscular contraction or mechanical work), in which muscular force is exhausted. The various secretions and excretions which take place in the animal body must be looked upon in the light of *disintegrating* actions; they cannot be looked upon in the same light as we view the generation of nerve force or muscular force; the compounds which constitute the secretions are thrown off, and do not form a permanent constituent of the animal body like the muscular or nervous tissues, although they may be intended for ulterior purposes; the principal office of the secretions and excretions may be to keep and maintain the blood in a

proper and fit state for healthy nutrition. Excessive secretion, as during lactation, many exhaust the vital powers in the same manner as excessive nerve action or muscular action, but we must bear in mind, when applying the principle of Conservation of Force in the explanation of natural phenomena, the distinction between the *formative* action by which the force is *generated* and the *disintegrating* or destructive actions by which the force is *expended*. The analogy which is drawn between the steam-engine and the animal body is too far fetched, if we compare the food and fuel on the one hand and the lungs and the furnace on the other: the respiratory function is not an act by which the vital force is *generated*, although it is one by which it is maintained. We cannot say that the vital force of the animal is generated, or originates in the combustion of the carbon which takes place in the lungs, as the power of the steam-engine originates in the combustion of the fuel which generates the heat; that which is primary in one is secondary in the other. During muscular action—the development of muscular power—we have heat evolved, chemical action taking place and electricity evolved, but we are not justified in saying that the mechanical power of the muscle is converted into chemical force, or into heat, or into electricity. It would be more in unison with the facts if we say that the muscular force developed and generated during the nutrition of the muscle is converted into mechanical power, heat, electricity, and chemical force, during muscular action. But we should naturally ask, What do we mean by muscular force? In what does it differ from mechanical power? And this shows us the impropriety of assuming what are mere properties to be forces. The term *conversion* gives but an inadequate idea of what is intended to be conveyed, and consequently inappropriate. The relation which heat, electricity, and chemical action bear to the power exerted by the muscle, in other words, their relative equivalents, is the point to be ascertained.

Similar observations may be made in regard to nerve force. Nerve force is generated and maintained during nutrition, and expended during nerve action. Nerve action

is no doubt accompanied with chemical changes which take place in its tissue, as in the muscles; but whether heat and electricity are developed, as in muscles during muscular action, is extremely problematical.

I have alluded in a former part of the paper to the fact that, during muscular action the nutrition of the muscle is increased, and consequently the muscular power is maintained, if not increased; here we have apparently a *creation* of force during work instead of exhaustion. If we bear in mind that it is during nutrition that the muscular force is generated and maintained, and that *time* must be taken into account in considering these phenomena, there is, notwithstanding the apparent creation of power, ultimately an exhaustion; and consequently these facts go far to establish the correctness of the principle of the Conservation of Force; at the same time show the extreme beauty of adaptation and contrivance in the animal machine when comparing it with the admirable contrivances formed and designed by human skill.

Collection of the Popular Weather Prognostics of Scotland.

By ARTHUR MITCHELL, A.M., M.D., Member of Council of the Scottish Meteorological Society, &c.*

1. *Minute of Council of the Scottish Meteorological Society, July 1863.*

The Council had laid before them by the Marquis of Tweeddale, a "Collection of the Popular Weather Prognostics of Scotland," drawn up by Dr Arthur Mitchell, M.D., accompanied by a letter from the author, dated 15th December, 1862, and addressed to his Lordship.

The Marquis repeated to the Council, what he had stated to the general meeting of the Society, held on 24th ultimo, that he considered it would be of use to publish these prognostics, and also very important to have them explained and tested on scientific principles. As the general meeting

* In connection with the paper the following minute and letter were transmitted.

had expressed approval of his views, he now begged to intimate his readiness to offer a prize of twenty guineas for the best scientific explanation of the prognostics collected by Dr Mitchell; and he would leave it to the Council to make all the arrangements necessary for carrying out his object.

The Council agreed to record their sense of the great liberality of the noble Marquis in this matter, and also their appreciation of the importance of the subject. They are of opinion that the best way of bringing the prize under the notice of persons likely to compete for it, would be to publish Dr Mitchell's collection of prognostics in the "Edinburgh Philosophical Journal," accompanied by a copy of this minute. They farther agree to intimate that the prize will be given in the form of a gold medal, a piece of plate, or otherwise as the successful competitor may desire.

The papers intended to be given in for this competition must be lodged with Mr Buchan, the Society's Secretary, at No. 10 St Andrew Square, Edinburgh, on the 1st May 1864.

Any persons wishing to have separate copies of Dr Mitchell's paper, may obtain them by applying to Mr Buchan.

DAVID MILNE HOME, *Convener*.

2. *Letter to the Most Noble the Marquis of Tweeddale.*

LAVEROCK BANK VILLAS, TRINITY, EDINBURGH,
15th December 1862.

To the Most Noble the Marquis of Tweeddale, President of the Scottish Meteorological Society.

MY LORD,—Along with this letter I forward to you a collection of the weather prognostics of Scotland, which I have made at your Lordship's suggestion. I have confined myself to those which are strictly popular in their character, and which do not involve the use of scientific instruments.

The object to be served by such a collection appears to be twofold:—

I. These prognostics are thus presented in a form which

facilitates the testing of their trustworthiness by careful and methodical observation.

II. By having them collected together, we are better able to compare and generalize.

In the effort to attain this object, we may find that phenomena, which are apparently unconnected, but which foretell the same change, are in reality allied through a common cause ; we may discover how it happens that certain classes of phenomena come to predict certain approaching conditions of the weather ; and further, it may happen that while sifting well-established popular beliefs, we may fall on the proof of important weather laws.

I shall illustrate my meaning, and at the same time show how such an inquiry may become interesting and valuable, both in a scientific and practical sense, by reference to the following prognostics:—

A heavy in-shore swell during calm weather is believed to foretell wind. This prognostic has been found to be very generally correct. The swell, in fact, is merely the product of a distant storm then existing, which is travelling towards us, and which will probably, though not certainly, reach us. The log-books of ships have satisfactorily established the truth of this explanation. We are led, therefore, to conclude that storms do not always travel so fast as does their influence on the water ; nor is this the only important conclusion concerning the progress of storms which flows from the examination of this single phenomenon.

Again, when the fisherman of the Dornoch Coast, on a clear and calm night, hears the sound of rushing waters over the *Gizzen-Briggs*, he expects a storm from the east. Now, it is more than probable that this sound is merely another manifestation of the precursory swell of which I have just been speaking, and which causes it by producing broken waters on the sandbank at the mouth of the firth. We have here an illustration of how phenomena seemingly unconnected may possibly be due to the same cause. The “*ebb and flow and ebb again*,” near high or low water mark, in narrow firths, a phenomenon which fishermen call *leakies*, may also have the same explanation, viz., the action on the water of a remote storm, perceived before the arrival of the

storm itself, but whose coming is thus predicted. Even the landward flight of the sea-gull may have the same origin. Before the storm has come the swell may have disturbed his feeding-ground, and thus made his flight inland for food a presage of stormy weather.

After some of the prognostics I have inserted remarks, suggestive or explanatory, and bearing either on a special phenomenon or on a class. When clouds, for instance, on the summits of particular mountains, are thought to foretell coming rain, I have indicated, as accurately as I could, the position of the mountain in relation to the locality in which the prognostic holds. The intention is obvious, being suggestive of one aspect in which phenomena of this class may be studied.

While making this collection, I embraced every opportunity which offered of conversing with those who were reputedly good weather-prophets, and I found two points of practical importance on which all appear to agree.

1. No sign is considered *infallible*. "It is not the less a sign, however," said a cautious and intelligent observer, who added, "We all trust the barometer, yet even it sometimes fails, and the clouds, *well understood*, are only a little less certain."

2. A prediction is seldom founded on a *single sign*. Never, indeed, have I seen the system of "putting that and that together" in more extensive operation. I have been told, again and again, that only by so doing can the coming weather with any certainty be predicted.

I now beg to offer a few remarks on the different classes of prognostics, indicating those on which I think the least reliance can be placed, pointing out the desirability of minute and full descriptions, and giving several reasons why some prognostics, which at first sight may seem valueless, deserve to be fairly considered before rejection.

It appears to me that the accusation of fanciful can with most fairness be brought against those prognostics which are associated with the aurora, halos, mock-suns, thunder, &c.

I have been led to form this opinion from finding that the same phenomenon is by different persons in the same locality made to presage totally different conditions of the weather. Appearances which are marvellous, startling, or uncommon, are apt to be accepted by the ignorant as prophetic of coming change of some sort. It is thus that the aurora has been thought to predict wind by some, and war by others, while the Eskimo looks on it simply as a game, which the spirits of departed relatives are playing.

There is also a probability that not a few of those prognostics which are connected with the conduct and movements of animals, will have to be rejected as groundless. But for several reasons I think that this must be done with caution. For instance, when the screaming of the peacock is said to indicate coming rain, I find that this does not refer to a cry once or twice repeated, which may have a score of causes, but to a persistent screaming, with evidence of discomfort, and without manifest cause. There is a great difference between the simple statement that the peacock's screaming foretells rain, and the other statement, with its important qualifications. In its bare form we might properly reject the prognostic as worthless, and as properly retain it when amplified.

It becomes, therefore, exceedingly desirable that we should possess a *full and minute description* of all popular weather prognostics. Of but a few in the collection can I pretend to have given this, which I believe can only be obtained through the co-operation of many observers, whose attention has been drawn to the things which should be observed by some such collection as that which I now forward. I frequently experienced the greatest difficulty in carrying away a clear understanding of the sky and cloud signs. "You must see the thing, sir, to know it," was often the end of a fruitless effort to make sure of what was meant. The roughest sketch in such a case would be of the greatest value. Of this Mr Clouston has given an illustration, which will be found at page 222.

There is another reason—and one of general application—for caution in rejecting any old popular prognostic as utterly worthless. Though *singly* it may be of little value,

yet *associated with others*, it may give strength, and the *whole* may be safely trusted in determining a debated course of action. Thus, the continued and distressed screaming of the peacock arrests the farmer's attention, and the first thing to which this leads is to his looking around for other signs, and he acts according to what he believes to be the teaching of the whole. I have said that he *acts* on this teaching, and this leads me incidentally to remark, that it is the fact that important operations are every day *actually determined* by such indications, which makes it so desirable to have the false separated from the true, so that the shepherd, the farmer, and the sailor, may trust only to prognostics which are ratified by experience, and, when possible, grounded on reason.

The great antiquity of many of these weather proverbs is also a substantial argument against hastily dismissing them. Peculiarities in the flight and conduct of birds have been held to foretell approaching change of weather for thousands of years. We might suspect this to be a mere extension of the drawing of auguries from them. The victory at Artemesium was assured to Themistocles by the crowing of a cock. Indeed, ornithomancy was an actual science among the early Greeks. But this doubt as to the origin of such weather prognostics is removed by the manner in which Virgil handles them. In his allusions there is nothing of the supernatural or mysterious. He speaks of them as simple deductions from the experience or observation of those whose occupations led to the looking for signs of coming storms. It is true, they may now be called traditional, but as every generation has had the opportunity of testing their accuracy and value, unless they had been found to contain some measure of truth they would soon have ceased to be handed down. It must not be forgotten that they regulate affairs of every-day life, and lead to loss or gain—a test which soon deprives traditional error of its vitality; and this is only a little less slowly its fate when it is linked to or mixed up with religious belief.

So it is with that class of prognostics to which St Swithen's day belongs. In Scotland, at the present time, there is practically no faith placed in them. Except St Swithen's

day, indeed, few are known, and with regard to it careful observation has proved to us that

“Nor Paul nor Swithen rules the clouds and winds.”

I have not included in my collection the numerous prognostics of this kind drawn from festivals in the calendar, first, because they are not now believed in or even known to the people; and, secondly, because they are manifestly not worthy of belief. The very uncertainty as to whether they should be computed by the Gregorian or Julian Calendar is fatal to them. For similar reasons I have not included those prognostics connected with certain days or months, as, for instance, when the direction of the wind on New Year's Eve is made to betoken the weather of the whole incoming year. It is a mistake to suppose that such prognostics are now believed in by the people of any part of Scotland. It is doubtful indeed if the belief in them was at any time general. They probably originated in the fancy of some *prophetic rhymster*, and to a quaint rhyming they are indebted for the life which they have had.

The *wide diffusion* of many popular prognostics is the only other claim for consideration which I shall notice. Not a few of those most familiar to us in Scotland are popular beliefs not only throughout Europe, but also among many of the nations of the East and South. Many of these appear to rest on a wide-spread *faith in the steadiness of annual averages*, and in a supposed *system of compensations* which this belief almost involves.—With great respect, I am, my Lord, your most obedient servant,

ARTHUR MITCHELL.

NOTE.—(1.) Only strictly popular weather prognostics are included in this collection. None of them involve the use of scientific instruments.—(2.) Of the great majority I am able to state that they are not obsolete, being still used as practical guides in daily life.—(3.) I have not thought it right to exclude any because they seemed to me valueless, if others had faith in them.—(4.) Many of them are mentioned in the tours of Martin, Pennant, Boswell, Johnston, Anderson, Maculloch, &c.; and I have found a considerable number scattered through the Old and New Statistical Accounts. Between twenty and thirty have been furnished

to me by Archibald Gibson, Esq., and I have extracted a few from the recent returns to the Scottish Meteorological Society, while others, so far as I am aware, are nowhere recorded.—(5.) I could give more than one authority for the greater number, and numerous authorities for many, so that I have thought it best to give no references where the prognostics are popular ones.—(6.) When I fell in with any popular prognostic in the course of reading I noted it down, and made inquiries on the subject when I reached the locality in which it was said to hold. Thus I established its existence, and at the same time put myself in the way of hearing of others.—(7.) The notes must be regarded as simply suggestive, and their accuracy must not be assumed.—(8.) It is possible that errors may have been made in taking down some of the prognostics.—A. M.

I. Hills or Mountains—Local Prognostics.

(1.) In Kilconquhar and Elie, a cloud resting on Largo Law is a sign of coming rain, while one on Kellie Law presages clear weather. This is interesting, because the first hill lies to the west, and the last to the east of the district. The popular version of this prognostic is as follows:—

1. When Largo Law puts on his hat,
Let Kellie Law beware of that.
2. When Kellie Law gets on his cap,
Largo Law may laugh at that.

(2.) To the people of Sorbie, in Wigtownshire, a cloud on Cairns-muir after dry weather indicates coming rain, and in the adjoining parish of Whithorn the same prognostic runs thus:—

“When Cairnsmuir wears a hat,
The Machers’ rills may laugh at that.”

Cairnsmuir (1737) hill lies to the N.N.E. of the district in which this prognostic prevails.

(3.) To the people about Stranraer there is a prognostic thus expressed in rhyme:—

“There is a high wooded hill, above Lochnaw Castle,
Take care when Lady Craighill puts on her mantle;
The Lady looks high and knows what is coming,
Delay not one moment to get under covering.”

This hill lies to the north-west of the district in question.

(4.) In Dumfries, Kirkpatrick-Fleming, and several of the in-

tervening parishes, the rolling of clouds landward, and their gathering about the summit of Criffel, is regarded as a sure indication of approaching foul weather.

Criffel lies to the south-west of these places.

(5.) Heavy clouds on Skiddaw, especially with a south wind, the farmer of Kirkpatrick-Fleming looks on as an indication of coming rain.

Skiddaw lies to the south.

(6.) A cloud on the top of the Sidlaw Hills foretells rain to the people of Carmylie.

The hills lie to the west of that district.

(7.) In New Cumnock there is a saying that, "If Corsancone puts on his cap, and the Knipe be clear, it will rain within twenty-four hours." This sign, it is said, never fails.

Corsancone Hill (872) is to the east, and the Knipe (1260) to the south-west of the New Cumnock district.

(8.) When the summit of the Bin Hill, to the south-west of Cullen, is covered with mist, rain is thought to be not far off.

(9.) The natives of Gigha and Cara anticipate rain when the Paps of Jura (to the north-west) are capped, and if the cloud be white, they expect wind with it. The Mull of Kintyre to the south, is used in the same way.

(10.) The capping of the Paps of Jura serves also as a prognostic of rain to the people of Kilcalmonell and Kilberry, which lie to the east of these peaks.

Note.—When a thick cloud on the top of a hill is observed to be in motion, the certainty of the prognostic is regarded as increased.

II. *Mists and Fogs.*

(1.) In the evenings of autumn and spring vapour arising from a river is regarded as a sure proof of coming frost.

(2.) Hazy weather is thought to prognosticate frost in winter, snow in spring, fair weather in summer, and rain in autumn.

(3.) Thin, white, fleecy, broken mist slowly ascending the sides of a mountain whose top is uncovered, predicts a fair day.

(4.) The following is a well-known *saw*, common among anglers in Balmaclellan, and generally in Kirkcudbrightshire:—

“ When the mist creeps up the hill,
Fisher out and try your skill,
When the mist begins to nod,
Fisher then put past your rod.”

(5.) White mist in winter indicates frost.

III. *Appearance of the Sky.*

(1.) A small cloudless space in the north-east horizon, especially if the clouds generally are moving to the south or south-west, and if the weather has previously been wet, is regarded all over Scotland, among seamen and landmen, as a very certain precursor of fine weather, or a *clearing up*.

(2.) In winter when the sky about mid-day has a greenish appearance to the east or north-east, snow and frost are expected.

(3.) “The evening red, and the morning grey,
Is the sign of a bright and cheery day;
The evening grey, and the morning red,
Put on your hat, or you'll wet your head.”

Note.—The red after sunset must have a crimson tinge, and must last for some time. The red about sunrise may be a mere glare, and short lived. In fact, if it hold out till the sun is fairly above the horizon, many look for a fine day—though this is apparently opposed to the popular prognostic.

(4.) When, in the morning, the dew is heavy and remains long on the grass, when the fog in the valleys is slowly dissipated, and lingers on the hill sides, when the clouds seem to be taking a higher place, and when a few loose cirro-strati float gently along, serene weather may confidently be expected for the greater part of that day.

(5.) Continuous cirro-strati gathering into unbroken gloom, and also the cloud called “Goat’s Hair” or the “Grey Mare’s Tail,” presage wind.

(6.) Light fleecy clouds in rapid motion below compact dark cirro-strati foretell rain near at hand.

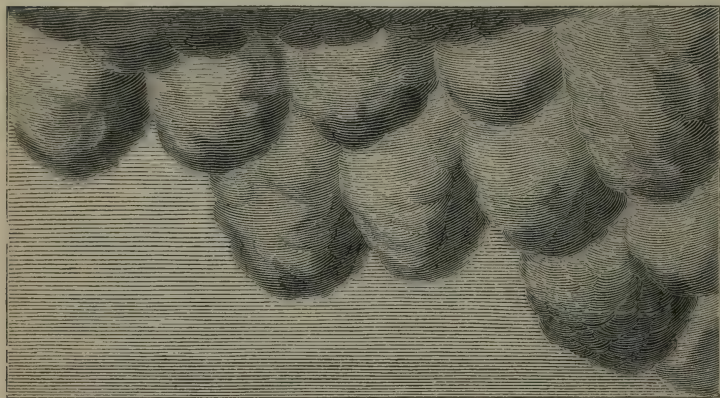
(7.) When, after a shower, the cirro-strati open up at the zenith, leaving broken or ragged edges pointing upwards, and settle down gloomily and compactly on the horizon, wind will follow, and will last for some time.

(8.) When, after a clear frost, long streaks of cirrus are seen with their ends bending towards each other as they recede from the zenith, and when they point to the north-east, a thaw and south-west wind may be expected.

(9.) Cumulous clouds, high up, are said to show that south and south-west winds are near at hand; and stratified clouds, low down, that east or north winds will prevail.

(10.) “I first observed this kind of cloud (cumulous-like festoons of drapery) on 5th March 1822, when the barometer fell from 29·5 at 10 A.M. to 28·3 at 7 P.M., and it was immediately followed by a storm. Since then I have seen it several times, and,

when properly developed, it was always followed by a storm or gale within twenty-four hours. It is called "Pocky Cloud" by our sailors. On this occasion, the gale began early next morning, and continued till 2 P.M."—*Rev. C. Clouston, Sandwick Manse.*



Pocky Cloud, from drawing by Mr Clouston.

(11.) Cirrus at right angles to the wind is regarded as a sign of rain.

(12.) The farmers in Berwickshire say that a long stripe of cloud sometimes called by them a salmon, sometimes called Noah's ark, when it stretches through the atmosphere in an east and west direction is a sign of stormy weather, but when it stretches in a north and south direction, is the sign of dry weather.

(13.) Along the north shore of the Solway, from Dumfries to Gretna, a lurid appearance in the eastern or south-eastern horizon, called from its direction "a Carlisle Sky," is thought a sure sign of coming rain. They describe it as lurid and yet yellowish, and the common saying is,—

" The Carle sky
Keeps not the head dry."

(14.) In Kincardine of Monteith, and in all that district of country, the reflection from the clouds of the furnaces of the Devon and the Carron (to the east) foretells rain next day.

(15.) The glare of the distant Ayrshire ironworks being seen at night from Cumbræ or Rothesay, rain is expected next day. Similar prognostics are common all over Scotland.

(16.) A *mackerel* sky denotes fair weather for that day, but predicts rain a day or two after.

IV. *Moon and Sun, Rainbow, Aurora Borealis, Falling Stars, and Thunder.*

(1.) A few days after full or new moon, changes of weather from good to bad or bad to good, are thought more probable than at other times.

(2.) In winter, when the moon's horns are sharp and well defined, frost is expected.

(3.) When the moon has a white look, and when her outline is not very clear, rain or snow is looked for.

(4.) "Clear moon,
Frost soon."

(5.) If the old moon embraces the new moon, stormy weather is foreboded. Great confidence is placed in this old prognostic :

"I saw the new moon late yestreen
Wi' the auld moon in her arm,
And if we gang to sea, master,
I fear we'll come to harm."—*Sir Patrick Spens.*

(6.) Haloes predict a storm (rain and wind, or snow and wind) at no great distance, and the open side of the halo tells the quarter from which it may be expected.

(7.) Mock-suns predict a more remote and less certain change of weather.

(8.) "A rainbow in the morning—
Sailors take warning ;
A rainbow at night
Is the sailor's delight."

NOTE.—In the former case the rainbow will appear in the west, and in the latter in the east. In studying the prognostic this should be borne in mind.

(9.) The aurora borealis indicates change, especially if lurid and fiery. It is thought by many that a south-west wind often follows. Others, however, look for cold and storm when the aurora is very vivid. By some it is less, and by others more dreaded when seen low in the horizon. Many speak of it simply as indicating change—good to bad, or bad to good.

(10.) Numerous falling stars presage wind next day.

(11.) Sheet lightning, without thunder, during night, having a whitish colour, announces unsettled weather. In the west of Scotland, vivid flashes of lightning early in the morning are regarded as an unfavourable sign of the weather for that day.

(12.) A thunderstorm from the south is said to be followed by warmth, and from the north, by cold. When the storm disappears in the east, it is a sign of fine weather.

(13.) The fragment of a rainbow in the north, which is called the "Boar's Head," makes the boatmen keep a look-out for wind. Stubs, however, are very variously interpreted.

(14.) People speak of the new moon "lying on her back, and being ill made," as a prognostic of wet weather.

(15.) "For a period of between thirty-five and forty years I have never known an exception to the rule, that the first great aurora, after a long tract of fine weather in September or beginning of October, is followed on the second day, and not till the second, about one o'clock on the east coast, and about eleven o'clock in Nithsdale, by a great storm; and that the next day after the aurora is fine weather, fit for all agricultural purposes."—*Professor Christison. (Communicated by Thomas Stevenson, Esq.)*

Note.—Professor Christison's character as an observer gives great importance to this prognostic.

V. *Distant Objects seen with unusual Clearness.*

(1.) When to the people about Arbroath the Bell Rock light is particularly brilliant, rain is expected.

(2.) About Cape Wrath, and along that part of the coast, when the Orkney Islands are distinctly seen, a storm or a continuation of bad weather is prognosticated.

(3.) When from Ardersier and the adjoining parish on the south-east side of the Moray Firth, the distant Ross-shire hills are distinctly seen in the morning, rain is expected that day.

(4.) To the people in Eaglesham, when the Kilpatrick hills appear near, a change to wet is looked for, but when they appear remote, dry weather will continue.

(5.) When Ailsa Craig is distinctly seen, and seems near at hand, the people of Cumbrae look for change. When the weather is going to be fine, it lies flat, but when rain is coming it assumes the form of a mushroom.

Note.—Darwin, in his "Zoonomia," thinks that the presence of vapour in the air increases its transparency, on the same principle as saturating a white opaque sheet of paper with oil renders it transparent.

There is a saying in Shetland,—*Everything looks large in an east wind.*

VI. *Unusual Sounds.*

(1.) In the Kilconquhar district of Fifeshire, when the noise of the sea is heard coming from the direction of St Andrews or St Monance, which lie to the north and east, bad weather from that quarter is expected. And when, afterwards, the sound is heard

coming from Kineraig, or from up the Firth, or in other words from the west, the wind is expected to fall.

(2.) At Roseneath, when the tide-stream at the ferry flows gently, yet resounds like a cataract, though the sky be starry and cloudless, rain may be looked for in the morning.

(3.) When the people of Monzie hear the sound of the waterfalls of Shaggie, or the roar of the distant Turret clearly and loudly, a storm is expected; but if the sound seems to recede from the ear till it is lost in the distance, and if the weather be thick, a change to fair may be looked for speedily.

(4.) In Fortingall, if in calm weather the sound of the rapids on the Lyon is distinctly heard, and if the sound descends with the stream, rainy weather is at hand; but if the sound goes up the stream, and dies away in the distance, it is an omen of continued dry weather, or of a clearing up if previously thick.

Note.—The course of the Turret and Lyon is from west to east. This note refers to the two preceding prognostics.

(5.) Along the Dornoch coast, when the sound of the sea is distinctly heard as if breaking on the sandbank called the Gizen Briggs, at the mouth of the Firth of Dornoch, it forebodes a storm, which will probably be from the east or north-east. When this is reckoned on as a prognostic, it is said "that the weather must be calm, and the sea with nothing more than a swell on."

(6.) In winter, when the sound of the breakers on the shore is unusually distinct, frost is indicated. This is very generally believed in.

(7.) If the noise of a steamer or a railway train is heard at a great distance, bad weather is predicted.

VII. *Underground Prognostics.*

(1.) In the collieries about Dysart, and in those of other districts in Scotland, it is thought by the miners that before a storm of wind, a sound not unlike that of a bagpipe, or the buzz of a bee, comes from the mineral, and that previous to a fall of rain the sound is more subdued.

(2.) Before wind and rain, it is also said, that the black damp, extinguishing the lights, is observed at the bottom of ironstone pits, and through the waste.

(3.) In Midlothian, the miners think that approaching changes of the weather are preceded by an increased flow of water, and the issue of gases and foul air from the crevices; and when very bad weather is at hand, these last escape with a characteristic sound, like the buzz of insects.

VIII.—*Plants.*

(1.) The *Convolvulus arvensis* (small bind-weed), *Anagallis arvensis* (scarlet pimpernel), and *Calendula pluvialis*, shut up their flowers before approaching rain. (The pimpernel has been called the poor man's weather-glass.) The same is believed to be true of the *Anemone nemorosa* (wood anemone), the *Oxalis Acetosella* (wood sorrel), *Nymphæa alba* (white water-lily), and *Bellis perennis* (common daisy).

Note.—Light probably determines the opening of most of these flowers, and their being found shut at 10 or 11 A.M. tells of cloud and gloom, and so predicts rain.

(2.) If *Stellaria media* (common chickweed) fully opens its flowers, no rain will fall for four hours.

Note.—Linnæus in his “*Botanica Philosophia*” shows that, with reference to the opening and closing of their petals, many flowers display an extreme sensibility; and it is quite probable that they may be influenced by those minor atmospheric changes which precede by a greater or less length of time the greater changes, and that they thus become real prophets of the approach of the last.

(3.) “Mony haws,
Mony snaws,”

is a common saying all over Scotland, and in some districts is otherwise expressed thus:—

“A haw year
Is a snaw year.”

(4.) When the bramble blossoms early in June, an early harvest is expected.

(5.) If the oak is out in leaf before the ash, it will be a dry summer. If the ash first, wet.

IX. *Conduct, Movements, &c. of Animals.*(A.) *Birds.*

(1.) The low flight of crows indicates coming rain. If they feed busily, and hurry over the ground in one direction and in a compact body, a storm (wind and rain) will soon follow. When they sit in rows on dykes or palings, wind is looked for. When going home to roost, if they fly high, the next day will be fair, and *vice versa*. If, when flying high, they suddenly dart down and wheel about in circles, wind is prognosticated. In autumn and

winter, if, after feeding in the morning, they return to the rookery and hang about it, rain is expected soon.

(2.) The landward flight and flocking of sea-gulls presage wind. When their cry is frequently repeated, when it is more lengthened and dismal than usual, and when it is heard in an inland place, rain or snow is prognosticated.

(3.) The frequently repeated cry of the ptarmigan low down on the mountains during frost and snow, indicates more snow and continued cold.

(4.) The gathering of grouse into large flocks indicates snow. Their approach to the farm-yard is a sign of severe weather—frost and snow. When they sit on dykes in the moor, rain only is expected.

(5.) When the cock crows at unusual times, wet or snowy weather is expected.

“If the cock crows on going to bed,
He’s sure to rise with a watery head.”

(6.) When the fieldfare, redwing, starling, swan, snowfleck, and other birds of passage, arrive soon from the north, it indicates the probability of an early and severe winter.

(7.) Swallows and swifts fly close to the ground or water before rain.

Note.—As a rule they fly lower in the evening and morning than during the day. Before thunder, however, they are often seen flying high. Such birds probably move about in that stratum of air in which the insects on which they feed are at the time, and that stratum is selected for warmth and dryness.

(8.) The drumming of the snipe in the air, and the call of the partridge, indicate dry weather and frost at night to the shepherds of Garrow.

(9.) “When dotterel do first appear,
It shows that frost is very near;
But when the dotterel do go,
Then you may look for heavy snow.”

Common also among Hampshire shepherds.

(10.) In severe winters the white swan visits the Orkneys. Its coming foretells continued severity.

(11.) When hens are observed to pick and pluck themselves more than usual, rain is near.

(B.) *Quadrupeds.*

(1.) Goats leave the high and exposed grounds, and seek shelter in a *bieid* or in some recess, before a storm.

(2.) Old sheep and ewes (less faith is placed in hogs) are said to eat greedily before a storm and sparingly before a thaw. When they leave the high grounds, and bleat much in the evening and during the night, severe weather is expected. In winter when they feed down the hill, a snow storm is looked for. When they feed up the burn, wet weather is near.

(3.) Swine carry straw in their mouths, and toss about their bedding before a storm.

(4.) Cats are observed to scratch the wall or a post before wind, and to wash their faces before a thaw. They sit with their backs to the fire before snow.

(5.) A day or two before rain, moles raise more hillocks than usual, and it is a sign of thaw when, after a long frost, they begin to work again.

(6.) Weasels, stoats, &c., seen running about in the forenoon, foretell rain in the after part of the day.

(7.) Hares take to the open country before a snow storm.

(C.) *Insects, Worms, &c.*

(1.) When gnats bite keenly, and when flies keep near the ground, we look for wind and rain.

(2.) Insects fly low before rain.

(3.) The earthworm appearing in large numbers on the surface indicates rain.

(4.) A leech in a bottle is considered a good weather prophet by many people. It is thought that in dry, calm weather, be it cold or hot, the leech will remain at the bottom; before rain or snow that it will cling to the side of the bottle at the top of the water; and that before wind it will be found in active motion.

(5.) When the colour of frogs is observed to be dark, wet weather is thought to be very close.

(6.) When the frog spawns in the middle of the water it is a sign of drought, and when at the side it indicates a wet summer.

(7.) When bees fly to the hive and none leave it, rain is near.

(D.) *Sensations experienced by Man.*

(1.) Headache, toothache, pain in corns, rheumatism, neuralgic pains, &c., are felt by some people before change from dry to wet, or mild to cold. Before thunder a feeling of listlessness, oppression, and uneasiness, is often complained of.

X. *Unclassified Prognostics.*

(1.) An honest man and a north-west wind generally go to sleep together.

Note—This is a common saying, and implies that if the wind is from the north-west in the early part of the day, it will veer or fall in the evening. It is common also in Iceland. The *Westing* appears to be important, for in Orkney the saying is: *The west wind is a gentleman, and goes to bed.*

(2.) Much undulation in the air near the surface of the earth on a hot day in May or June foretells a lowering of the temperature. This is called *Startling Jack*.

(3.) It is said to be a sign of continued good weather when the wind so changes during the day as to follow the sun.

(4.) There is a peculiar rippling of the wind, or broken way of blowing, which is said always to prognosticate heavy rain within a few hours.

(5.) Easterly gales, without rain, during the spring equinox, foretell a dry summer.

(6.) Rain, with a south-east wind, is expected to last for some time.

(7.) Hail, after long-continued rain, indicates a clearing up.

(8.) Frost suddenly following heavy rain seldom lasts long."

(9.) Short, slight showers, during dry weather, are called *a hardening of the drought*. Dust rising from the road in dry weather, when there is little wind, predicts change.

(10.) The Tweed, near its mouth, sometimes rises when no rain has fallen there. Rain, however, may be expected, and a south-west wind.

(11.) On the west coast, a gale from the west or south-west is frequently prognosticated by a great swell of the sea occurring during calm weather. The same phenomenon on the east coast would indicate a storm from the east or north-east, but the comparative narrowness of the waters on that side of our country probably makes this sign less valuable and less likely to occur.

Note.—That veteran observer, the Rev. C. Clouston, has directed attention strongly to this, which he has himself often verified.

This prognostic implies the existence of a storm in a distant part of the ocean, which is travelling in the direction of our country, and it involves the notion that the agitation caused by the wind on the water's surface travels faster than the wind itself. Mr Clouston also concludes from it that the breeze begins to windward, and takes some time to reach the point to which it proceeds to leeward.

The distant storm, which causes this agitation, may not actually reach our coasts, and the sign may thus fail.

(12.) When the tide begins to ebb before high-water mark, and after receding a short distance, returns to high-water mark, or when, before low water, it flows for a short time and then ebbs again beyond the point from which the irregular flow started, a storm is believed to be near. These phenomena are vulgarly called *Leakies*. This prognostic is more particularly trusted on the shores of the Firth of Forth above Burntisland.

(13.) “Lang foul, lang fair,”

Note.—This is a calculation of probabilities, and springs from a faith in the constancy of averages in climate, as is the case with many other popular prognostics.

(14.) An unseasonably fine day in winter or spring is called a *pet day* in Scotland. The fate of pets, they say, awaits it, and they look for bad weather on the morrow.

(15.) “Who doffs his coat on a winter day
Will gladly put it on in May.”

(16.) “If the grass grows in Janiveer
It grows the worse for ’t all the year.”

(17.) A green Yule makes a fat kirkyard.

(18.) “Winter thunder
Bodes summer hunger.”

(19.) “Long foretold, long last;
Short notice, soon past.”

(20.) March dust is worth its weight in gold.

(21.) “April showers
Bring summer flowers.”

(22.) “In April a dove’s flood
Is worth a king’s good.”

(23.) “A shower of rain in July,
When the corn begins to fill,
Is worth a plough of oxen,
And all that belongs theretill.”

(24.) The sailor notes the tightening of the cordage on his ship as a sign of coming rain.

(25.) A lump of kelp acts as a good hygrometer, and prognosticates rain when it becomes damp.

(26.) When walls, built of stones which have been quarried below high-water mark, become damp, wet weather is near.

(27.) When from drains or soil-pipes a bad odour proceeds, foul weather is thought to be predicted.

(28.) When chimneys smoke and soot falls, bad weather is at hand. The whistling of the wind heard within doors denotes rain. When fires burn faster than usual, and with a blue flame, frosty weather may be expected.

(29.) When milk becomes suddenly and inexplicably sour, a thunder storm is at hand.

(30.) When spiders' webs are seen floating about in the air, farmers regard it as a sign of coming rain.

(31.) Heavy dews in hot weather indicate a continuation of fair weather, and no dew after a hot day foretells rain.

(32.) Addressed by Dr Jenner, in 1810, to a Lady who asked him if he thought it would rain to-morrow.

“ The hollow winds begin to blow,
The clouds look black, the glass is low :
The soot falls down, the spaniels sleep,
And spiders from their cobwebs creep :
Last night the sun went pale to bed,
The moon in halos hid her head :
The boding shepherd heaves a sigh,
For see a rainbow spans the sky ;
The walls are damp, the ditches smell,
Closed is the pink-eyed pimpernel ;
The squalid toads at dusk are seen
Slowly crawling o'er the green ;
Loud quack the ducks, the peacocks cry,
The distant hills are looking nigh ;
Hark, how the chairs and tables crack,
Old Betty's joints are on the rack ;
And see yon rooks how odd their flight,
They imitate the gliding kite,
Or seem precipitate to fall
As if they felt the piercing ball ;
How restless are the snorting swine,
The busy flies disturb the kine ;
Low o'er the grass the swallow wings,
The cricket too, how sharp she sings,
Puss on the hearth with velvet paws
Sits wiping o'er her whiskered jaws ;
The wind, unsteady, veers around,
Or settling in the south is found ;
The whirling wind the dust obeys
And o'er the rapid eddy plays ;
The leech disturbed is newly risen
Quite to the summit of his prison ;—
'Twill surely rain, I see, with sorrow,
Our jaunt must be put off to-morrow.”

APPENDIX (A).

The Shepherd of Banbury's Rules to Judge of the Change of the Weather.—Extracts from the Second Edition, printed in London in 1748.

In the preface it is said, “ Most of our Shepherd's observations give us a day's notice, many a week's, and some extend to several months' prognostication of the changes of weather ; and of how great use these may be to all ranks and degrees of people,—to the sedentary valetudinarian as well

as the active traveller,—to the sportsman who pursues his game, as well as the industrious husbandman, who constantly follows his labour,—in short, to every man in every situation in some degree or other, is so very clear and intelligible, that it would be a mere waste of words, and a very idle display of rhetoric, to attempt the making it clearer. Every man living would be glad to foresee the alterations of the weather if he could; and, consequently, to most people, if not to all, these observations, grounded on no less than forty years' experience, cannot but be acceptable."

I. SUN.—(1.) If the sun rise red and fiery—*Wind and rain.* (2.) If cloudy, and it soon decrease—*Certain fair weather.*

II. MOON.—(1.) Horns of the moon obscure—*Rain.* (2.) When the moon is red—*Wind.* (3.) On the fourth day of the new moon, if bright, with sharp horns—*No winds nor rain till the month be finished.*

III. STARS.—(1.) When stars shoot precipitant through the sky—*Approaching wind.*

IV. CLOUDS.—(1.) Clouds small and round, like a dapple grey with a north wind—*Fair weather for two or three days.* (2.) Large like rocks—*Great showers.* (3.) If small clouds increase—*Much rain.* (4.) If large clouds decrease—*Fair weather.* (5.) Clouds in summer or harvest, when the wind has been south two or three days, and it grows very hot, and you see clouds rise with great white tops like towers, as if one were upon the top of another, and joined together with black on the nether side—*There will be thunder and rain suddenly.* (6.) If two such clouds arise, one on either hand—*It is time to make haste to shelter.* (7.) If you see a cloud rise against the wind or side wind, when that cloud comes up to you, the wind will blow the same way that the cloud came. And the same rule holds of a clear place, when all the sky is equally thick, except one clear edge.

V. MISTS.—(1.) If mists rise in low ground and soon vanish—*Fair weather.* (2.) If they rise to the hill tops—*Rain in a day or two.* (3.) A general mist before the sun rises, near the full moon—*Fair weather.* (4.) If in the new moon—*Rain in the old.* (5.) If in the old—*Rain in the new.*

VI. WINDS.—(1.) Observe that in eight years' time there is as much south-west wind as north-east, and consequently as many wet years as dry. (2.) When the wind turns to north-east, and it continues two days without rain, and does not turn south the third day, nor rain the third day, it is likely to continue north-east for eight or nine days—*all fair*; and then to come to the south again. (3.) If it turn again out of the south to the north-east with rain, and continue in the north east two days without rain, and neither turns south nor rains the third day—*It is likely to continue north-east for two or three months.* The wind will finish these turns in three weeks. (4.) South-west winds. After a north wind, for the most part two months or more, and then coming south—*There are usually three or four fair days at first, and then on the fourth or fifth day comes rain,* or else the wind turns north again,

and continues dry. (5.) If it return to the south within a day or two without rain, and turn north with rain, and return to the south in one or two days as before, two or three times together after this sort—*Then it is like to be in the south or south-west two or three months together, as it was in the north before. The winds will finish these turns in a fortnight.* (6.) Fair weather for a week, with a south wind, is like to produce a great drought, if there has been much rain out of the south before. The wind usually turns from north to south, with a quiet wind without rain, but returns to the north with a strong wind and rain; the strongest winds are when it turns from south to north by west. (7.) When the north wind first clears the air, be sure of a fine day or two.

VII. RAINS.—(1.) Sudden rains never last long; but when the air grows thick by degrees, and the sun, moon, and stars shine dimmer and dimmer—*Then it is like to rain six hours usually.* (2.) If it begin to rain from the south, with a high wind, for two or three hours, and the wind falls, but the rain continues—*It is like to rain twelve hours or more, and does usually rain till a strong north wind clears the air.* These long rains seldom hold above twelve hours, or happen above once a year. (3.) If it begins to rain an hour or two before sun-rising—*It is like to be fair before noon, and so continue that day;* but if the rain begin an hour or two after sun-rising—*It is like to rain all that day,* except the rainbow be seen before it rains.

VIII. SPRING and SUMMER.—If the last eighteen days of February and ten days of March be for the most part rainy, then the spring and summers quarters are like to be so too; and I never knew a great drought but it entered in that season.

IX. WINTER.—If the latter end of October and beginning of November be for the most part warm and rainy, then January and February are like to be frosty and cold, except after a very dry summer. If in October and November there be snow and frost, then January and February are like to be open and mild.

X. ANIMALS.—(1.) Cormorants swiftly returning from sea to land, making a great noise—*Winds.* (2.) The heron forsaking the fens and soaring aloft—*Winds.* (3.) Cranes forsaking the valleys, heifers snuffing the air, swallows fluttering about the lakes, frogs croaking, ants conveying their eggs from their cells, ravens flocking together and making a great noise, bees in clusters humming about the hive—*Rain.*

APPENDIX (B).

The three following popular Prognostics are discussed by

M. ARAGO :—

1. If the horns of the lunar crescent, on the third day after new moon, are sharply and clearly defined, the weather may be expected to be fair during the ensuing month.

2. If on the fourth day the moon project no shadow, we are to expect bad weather during the month.

3. A change of weather accompanies a change of the moon.

On Revolving Storms. By JOSEPH JOHN MURPHY, Esq.*

When the temperature of the air is in a state of convective equilibrium, or, in other words, when the difference between the temperatures of any two strata is that which is due to the difference of pressures, it is obvious that any decrease in the specific gravity of the lower stratum, whether from expansion by heating, or by mixture with watery vapour, which is lighter than air, will give that stratum a tendency to rise; but as an entire stratum cannot rise in mass, the air will flow upwards in vertical columns, the place of which may be determined by the smallest inequality in the ground, or motion on it. If the ascending force is powerful and the ground very dry, the ascending columns of air will be marked by clouds of dust or sand, and it is thus that the "dust-storms" of Western India, and the "sand-spouts" of the African desert, are produced.

Professor Hennesy has observed that such vertical circulation is shown to exist in our climate by the rapid fluctuation of a thermometer exposed to the free air in warm sunshiny weather; and cumulous cloud is produced when the watery vapour contained in such an ascending column is condensed by the cold of diminished pressure.

When condensation takes place in an ascending column, the cooling from diminished pressure will be retarded by the heat liberated in condensation, and the ascending column, at any altitude higher than that at which condensation has begun, will be warmer than the surrounding air on the same level, supposing, as at first, that the temperatures of the surrounding air are in a state of convective equilibrium.

When unity of weight of vapour is condensed, heat enough is liberated to raise the temperature of an equal weight of water by 1178° Fahr., minus the temperature at which condensation takes place. To estimate the effect of this in heating air, the quantity must be divided by $\cdot 2377$, which is the specific heat of air at constant pressure; and to estimate the effect of the condensation of unity of *volume*

* Communicated to the Belfast Natural History and Philosophical Society, 29th October 1862 and 7 January 1863.

of vapour, we take $\frac{5}{8}$ ths of the quotient, as watery vapour has only $\frac{5}{8}$ ths of the specific gravity of air. Supposing condensation to take place at 80° , the heating effect will be

$$\frac{5}{8} \cdot \frac{1178 - 80}{\cdot 2377} = 2877$$

In other words, the condensation of any given volume of vapour will liberate as much heat as, if concentrated, would raise the temperature of an equal volume of air by 2877° Fahr.

This heat will expand the air. The addition of a degree Fahr. of temperature expands air at 32° by a 492d of its volume, and at 80° by a 540th. Consequently the expanding effect at 80° will be, after deducting the destroyed volume of the condensed vapour,

$$\frac{2877}{540} - 1 = 4.35$$

In other words, for every cubic foot of vapour condensed, 4.35 cubic feet will be added to the volume of the air. This expansion will increase the ascending force of the column, and produce an outward flow of air at its top, a fall of the barometer *at* its base, and an inward flow *towards* its base to fill up the void.

The foregoing reasoning is identical with that of "Espy's Philosophy of Storms." In order, however, to estimate the force of indraft at the base of such an ascending column, it would be necessary to know not only the temperature at every height in the column itself, which is a matter of calculation when that at its base is known, but also the temperature of the surrounding air at every height, a subject on which very little is known for any given time and place; for the ascending force of one mass of fluid in another depends on the difference of specific gravity, and this with air depends almost entirely on the temperature.

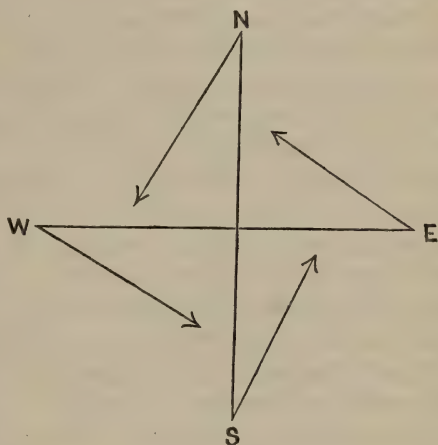
It has been stated by Professor Thomson of Glasgow, in a paper lately read at the Manchester Philosophical Society, that the temperature of air *saturated* with moisture, when in a state of convective equilibrium (as an ascending current of such air must necessarily be), will diminish at the rate of

1° Fahr. for every 294 feet of ascent ; but the temperature of dry or not saturated air will diminish at the rate of 1° for every 183 feet. Suppose that the air is nearly saturated in its lowest strata, and cloudless above, and that for the first few thousand feet of ascent the temperature diminishes at the rate due to convective equilibrium in dry air (conditions that sometimes occur in summer weather), the slightest increase of the temperature of the lowest stratum will produce an ascending current, in which the cold of diminished pressure will cause condensation to begin at a moderate height, and from that height upwards, the decrease of temperature will be at the rate of 1° Fahr. for 294 feet, while in the surrounding air it is at the rate of 1° Fahr. for 183 feet ; so that, at any given level, the air in the ascending column will be warmer and lighter than the surrounding air at the same level, and a powerful upward current will be produced, with a powerful indraft at its base. Of this nature, apparently, are many violent storms of small extent ; they are usually, perhaps always, accompanied by heavy rain or hail from the vapour condensed above.

Revolving storms or cyclones differ from these, primarily, in their larger extent. A cyclone cannot be formed unless the radius, within which the indraft due to the central barometric depression is felt, has a sensible magnitude in comparison with the earth's quarter-circumference. At its centre is an area of dense cloud, great barometric depression, and no wind. The air revolves round this, and has also an inward motion, producing a spiral resultant. The wind is most violent near the calm centre, and grows less so outward. They rotate in opposite directions in the northern and southern hemispheres ; in each hemisphere they rotate in the same direction in which the earth rotates round an axis drawn perpendicular to its surface, as shown in Foucault's pendulum experiment, that is to say, *against* the direction of the hands of a watch in the northern hemisphere, and *with* it in the southern. This is caused by the earth rotating under the currents of air, as it does under Foucault's pendulum, and deflecting their paths on its surface to the right in the northern hemisphere, to the left in the southern ; thus, in the northern hemisphere, the current from N towards an area

of rarefaction will be deflected toward W, that from W towards S, that from S towards E, and that from E towards N. As these deflections are all in the same direction round a circle, they combine and produce a vortex. All these directions are, of course, reversed in the opposite hemispheres. *The rotation of the storm is in the opposite direction to the deflection, or*

what Dové calls the gyration, *of the separate winds*, as will be obvious from the diagram, where the cross represents the converging paths which the winds would take in the absence of any deflecting force, and the arrows the directions in which they are deflected.



Of course it is not accurate to draw the arrows straight. Were there no friction, the velocity would be regulated by the law of the conservation of areas, and its tangential component in any part of the cyclone would be inversely as the distance from the centre. Cyclones never cross the equator, and are never formed on it, because the deflecting force is in opposite directions in opposite hemispheres, and null on the equator.

Such are the forces that move the cyclone. But the manner in which it is originally set agoing has not hitherto been fully explained. The following explanation is founded on that contained in Dové's recently translated "*Law of Storms*," and is partly identical with it:—

Cyclones are local and temporary phenomena: they occur chiefly in, 1st, The West Indian Seas; 2d, The Indian Ocean west of India; 3d, The South Indian Ocean; 4th, The Chinese Sea; and 5th, The Bay of Bengal: in all these they occur oftenest in the end of summer, except in the last, where they are most frequent twice a year, at the change of the

monsoons. They are certainly not formed in the South Atlantic, and we have no evidence of their existence in the Pacific, except perhaps off the coast of California.

They are formed only over tropical seas, because there only the air contains watery vapour enough to furnish their motive power by its condensation. But they originate in *eddies formed in the general circulation of the atmosphere.*

The heated air that rises up during summer over the warm regions of Asia and Africa flows out over the Atlantic as an upper current, where it meets the upper return trade wind. The direction of the former is nearly towards W., that of the latter nearly towards N.E., so that the resulting current will be N.N.W.; and on its right-hand side, towards Europe, eddies will be formed rotating *with* the hand of a watch, and on its left hand, or West Indian side, will be eddies rotating in the opposite direction. Any one may make such a pair of eddies by moving a teaspoon forward through a cup of liquid. At the centre of every eddy is a depression, produced by centrifugal force, and in an aerial eddy this will be marked by a diminution of barometric pressure. When the eddy rotates in the opposite direction to that of the cyclones of the hemisphere in which it occurs, no cyclone can be produced; but when it rotates in their direction, and other circumstances are favourable, the barometric depression at the centre produces cold—the cold of diminished pressure: this condenses part of the vapour in the air: heat is liberated, and an upward current produced, as explained at the beginning of this notice: an outflow of air takes place above and an indraft below: these radial motions combine with the rotatory motion of the eddy, and thus the eddy is converted into a cyclone.

The cyclones of the Indian Ocean west of India are produced in exactly the same way, by the meeting of the upper currents from the heated regions of Asia and Africa: and those of the South Indian Ocean, by the upper current from the heated regions of Australia meeting the upper return trade wind.

In these cases the eddy is formed originally in the upper strata of the air. In the Chinese Sea and the Bay of Bengal, on the contrary, it is formed on the surface of the sea,

by the meeting of the N.E. trade wind and the S.W. monsoon; this takes place over the Chinese Sea in summer, and over the Bay of Bengal after the equinoxes.

Besides their rotation, cyclones have a motion of translation, and this, within the tropics, is always *towards W.*; sometimes N.W., sometimes S.W., but always W. In the Chinese Sea this is contrary to the prevalent wind at the time they occur, which is the S.W. monsoon. This has not hitherto been accounted for. It is probably due to the fact that the rotation of the earth round an axis drawn perpendicular to its surface, as illustrated by Foucault's pendulum, varies as the sine of the latitude, and is consequently most rapid in the highest latitude; so that the higher the latitude from which the air in any part of a cyclone is drawn, the more it will have been deflected, and the greater will be its centrifugal force. Now, a glance at the diagram will show that the air on the west side of every cyclone comes from a higher latitude, and that on the east from a lower; the former has consequently the most centrifugal force, and determines the motion of the whole cyclone towards west.

It might be supposed that the motion in question is a resultant of the motions of the upper and lower currents of air, which in the tropical regions are usually different. This, however, could scarcely be reconciled with the fact that in the West Indian region the lower current (the trade wind) is from N.E., while in that of the Chinese Sea, during the prevalence of cyclones, it is from S.W. Little is known of the direction of the upper current in either case; it is probably rather fluctuating, but more nearly opposed to the lower currents than coincident with them. It appears probable that the resultant of the motions of the upper and lower currents in the West Indian region is more likely to be in the opposite direction to the same resultant in the Indian and Chinese region, than in nearly the same direction.

The cyclones of the West Indian Sea and South Indian Ocean, besides their motion to west, generally move towards the Pole. On reaching a latitude of about 28° , they lose much of their force, widen rapidly, and, losing their motion towards west, drift eastward and Pole-ward, with nearly the

general motion of the lower strata of the atmosphere in the middle latitudes. These changes have not been satisfactorily accounted for. *Perhaps* they are due to the fact that in tropical latitudes the general direction of the upper and lower air-currents is usually very different, while in higher latitudes it is usually nearly identical; in the former the cyclone, extending from the lower into the upper current, is as it were compressed between them: when it gets into the latter, being no longer thus compressed, it expands by its own centrifugal force, loses force by expansion, and drifts in the general motion of the air. Its motion, however, is more Pole-ward than this, and is perhaps a resultant of the general motion of the air, and a remaining westward tendency of the cyclone, due to the cause already explained.

Description of a Plant-house at Rockville, Blackrock, near Dublin. By Mr JAMES BEWLEY.*

My fern-house is a triple-span roof standing north and south, 60 feet wide—*i.e.*, three spans of 20 feet each; the length is 48 feet; the height of the sides to the spring of the roof is 13 feet 6 inches—of this, 7 feet is a wall; in the lower part are ventilators near the ground, which are opened and shut from the outside; the rest of the sides is glazed with fine ribbed glass. I think it is called Hartley's rough plating. The centre span is supported by three pillars, 12 feet apart from centre to centre. These pillars are rough brown slate, square, about 3 feet each way. The stones are laid horizontally, with ample spaces between, from the mortar being picked out for plants. From pillar to pillar are Gothic arches of the same material, covered with ferns, lycopods, &c. Thus there are two rows of four arches each. Each side has in addition a row of eight arches of 6 feet each, planted in the same manner, each roof rises about 7 feet; so the highest part of the house is 21 feet. The north end is a wall, against which is a mass of

* Communicated by Mr N. B. Ward to the British Association Meeting at Newcastle-on-Tyne, August 1863.

irregular rockwork about 10 feet high, with concealed steps to the top, and from these a path from side to side to enable a view to be had of the plants below, there being a number of tree ferns standing on the floor. This path is depressed so as to allow a person to pass under the lowest part of the roof. On the north side of the path, the rockwork is carried up to the top of the house, so that when viewed from below, the rockwork is seen to extend from the ground to the glass. An irregular rockwork is also carried round the south end, and along the east and west sides, up to the glass (7 feet); but it is separated from the outer walls by a space of 6 inches to allow ventilation from the outside, and also for the circulation of heat, from a pair of 4-inch water-pipes which run round the house. This is the only heating power. In order to promote a circulation of air, there are openings, in fact small concealed arches in the rockwork, on the ground level, passing through it to the narrow space next to the outer wall. Thus the hot-water pipes being next to the outer walls, and there being ventilators in these, and openings on the ground level inside, through the rockwork, there is a perfect circulation of air maintained—a matter all important to the health of plants. The roof is one of ordinary construction; wooden rafters 4 feet apart, with three light iron sash bars between. (I may here remark, I prefer the combination of wood and iron to either exclusively. All iron has too uniform an appearance to please me. Wooden rafters 4, 5, or 6 feet apart break the dull uniformity into spaces, and are of great practical convenience, by enabling a nail, screw, or hook to be put in whenever wanted.) The inner glass is common 21 oz.; it is put in about 7 inches on the *under side* of the rafter; so that, the rafter being about 6 inches in depth, 5 inches of it are outside. Now, on these rafters the outer roof rests—simple framed sashes, 4 feet wide,—and for the convenience of moving, in two lengths. They are glazed with the same glass as the sides, and are fixed in their places by a screw bolt, so as to be removed when required. Thus the inner and outer glass are from 5 to 6 inches apart. I do not think the distance is important; anything from 4 to 6 inches will do; but what is all im-

portant is, that the outer sashes should fit close, so as to admit of no circulation of air between. I do not like moveable sashes for top ventilation in any house, and therefore in mine I carry up the glass only to within one foot from the top of the ridge; above this are wooden shutters or panels for ventilation, and by a very simple contrivance they can be opened or shut.

Now, as to temperature. My fern-house being 60 feet by 48, with a mean height of about 16 feet, contains 46,000 cubic feet of space; and there being a pair of 4-inch hot-water pipes running round it, the heating power is 430 feet of pipe, or about 1 foot of pipe to 100 of cubic contents. In a single roofed house, I do not think this heating power would do more than exclude frost in severe winter weather, but with the double roof, the thermometer rarely goes below 48. I think I *once* saw it at 46. My estimate is that I gain 14 or 15 degrees of heat from the double roof. The loss of heat is very slow in cold weather; I think it would take three or four nights of *severe* frost to bring the heat of the house down from 52 to 48; and probably thirty-six hours to cause the same reduction were the fire to be left out altogether. With a single roof, this would be expected in, I think, about six hours. It is a great comfort to know that if, in any house I have, the fire was let out, or neglected in the depth of winter for a whole night, its contents would suffer no damage. The reverse effects are equally interesting,—the very slow increase of heat in warm weather. This has been a hot summer, yet the heat of the fern-house has never, that I am aware of, gone up to 70; with a single roof, and the same amount of ventilation, the house would run up to 80 or 85 in a single hot morning. There is another interesting fact, and one of great importance in plant-growing: there is a steady uniform increase of temperature in the house according as we ascend from the floor, day and night. This arises from the non-transmission of heat through the roof. Thus, while I have native ferns and other temperate plants growing below, I have tropical plants, ferns, and palms, &c. growing on the higher portions of the rockwork. And while, in ordinary houses, we remove tender plants from near the glass in severe weather, the nearer I

place them to it, the warmer they are. This is curiously indicated by the little creeping Ficus and other plants clinging to the under side of the inner glass, and spreading over it, apparently in great enjoyment. Another important result takes place from the non-radiation of heat through the roof. In ordinary houses, where moisture forms a requisite of good plant-growing, no matter how freely we use the syringe in the evening, we find the house *dry* in the morning, arising from the great condensation of moisture on the roof, and running off when thus condensed. The cooled air having parted with its moisture in the morning when the temperature rises a little, it becomes absolutely dry, to the great detriment of the plants. With the double roof, there is very little condensation on the roof, the blanket of non-conducting air between the two roofs of glass preventing it; and consequently, as the air cools down a little at night, the condensation takes place on *the plants themselves*, exactly according to nature. I have gone into my orchid-house, which has a double roof and sides, of a morning, and have seen the plants as beautifully covered with dew as a plot of cabbages on a May morning. Is not this nearly the perfection of plant-growing? We generally commence fire heat in the fern-house when the cold weather sets in, in the latter end of October, and leave it off in March, when the house gets about 54. Thus we have fire for about five months only in the year, and during these five months, the consumption of fuel is not more than one-half of what it would be if the house had but a single roof. Now, using only half fuel for five months, and none during the other seven, causes a very large saving, and to this must be added the saving from no fire attendance during the same seven months,—no small item. These together I calculate to amount to about 20 per cent per annum, on the extra cost expended on the double roof. But this is trifling compared with the enhanced value of the plants grown in a double-roofed house. The effect is astonishing. Plants which with difficulty held their own, or but slowly improved in an ordinary house, have grown and improved with me in a way that would surprise plant-growers in general. I should add, there is one point on which great caution is requisite

by any one who adopts double-roofed houses: from the uniformity of temperature, and the consequent non-condensation of moisture, very moderate waterings and syringes are sufficient to keep the plants in health. A beginner will be very apt to overdo it. My fern-house has nothing done to it for weeks together beyond a very light syringing each morning in summer, two or three times a week in spring and autumn, and once every week or ten days in winter.

My large plant-house is about 130 feet long, 19 wide, and 11 high. It had shelves at either side 3 feet wide, then paths of equal width, and a central stand 7 feet wide; beneath each of the side shelves there were two 4-inch flow pipes and two returns, twelve pipes in all. When I double-roofed it, the heat was too much, so I built a low brick wall on either side, and also enclosed in the same way the central 7 feet, and filled up the spaces with gravel, &c., to about 3 inches over the pipes; the gravel is kept damp, and on it the plants stand—on a hotbed, in fact, and they delight in it. I think any one who will cover up all his heating power in this way will soon find that it is superior to exposure; the heat is so gradually diffused and the moisture also, the gravel beds being frequently watered. The peculiarity and advantage of double-roofed houses may be summed up thus:—Great economy of heating power, and great uniformity of temperature and moisture; and consequently remarkable facility in growing plants in perfect health and beauty. So far as my experience has gone—and I have now been trying it for some years,—I can have no hesitation in recommending the system to every person for the cultivation of *any* description of plants.

The Great Mixed Forests of North America in Connection with Climate. By J. B. HURLBURT, LL.D.*

This vast forest, composed principally of deciduous trees, covers an area of about 2,000,000 square miles, extending from the Gulf of Mexico to the northern boundary of Canada, and from the Atlantic to the prairies of the west,

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in some places beyond, and in others not to the Mississippi. From this to near the Pacific, within the limits of the United States, intervene the naked interior plains for nearly 4000 miles, succeeded on the Pacific coasts by the forests of Coniferæ. From about the 98th meridian west, the forests of deciduous trees extend in a north-west direction high up into British America, with a belt of low evergreens around Hudson's Bay, and to the east of the northern parts of the valley of Mackenzie's River.

This vast compact forest, made up mainly of deciduous trees, is interspersed with large areas covered with coniferæ, and with others covered with deciduous trees and coniferæ intermixed, and to the south with tropical evergreens.

These peculiar forests, prairies, and desert areas, no doubt express some distinctive features of climate. Two conditions of climate—heat and humidity—marked in a high degree, seem essential for the development of those gigantic forests of deciduous trees. High summer temperatures and abundance of summer rains, are characteristics of the whole of the area covered by these forests. The temperatures for the three summer months over all these forest areas within the United States, Canada, and British America, are above 65°, and mostly above 67° of Fahr.,—temperatures high enough and long enough continued to mature maize, or Indian corn, and the grape; for the wild vine (*Vitis cordifolia*) matures its fruit to the northern limits of the deciduous forests. Twenty inches of rain in the states bordering the Gulf of Mexico, and ten inches in the north and through Canada, give, in general terms, about the quantities that fall during the three hottest months—June, July, and August. Similar high summer temperatures prevail over the western prairies and interior desert areas, but with a partial or total failure of the summer rains, and here we find the absence first of all forests, and then of all vegetation. On the Pacific coast, in high latitudes especially, the summer rains are abundant, but the summer temperatures are low, falling to 57° and 60°; and here are the most extraordinary examples of the coniferæ, but the deciduous trees are wanting.

Within the limits of these three great divisions we meet

with many modifications, which, however interesting, as illustrating the effects of climate upon the flora of that continent, it forms no part of the objects of this short paper to particularise ; but an example or two may be given. We have upon the White Mountains of New England an instance of the failure of all forest trees above an altitude of 5000 feet. The summits of the Black Mountains of North Carolina, as the *swartz wold*, or black forest of the hills of Badan, are covered with balsam firs, and the shores of Hudson Bay with low evergreen forests. In all such localities the results are what the lower summer temperatures might have been expected to produce, as the higher temperatures of the coasts of the Gulf of Mexico and the Atlantic as far north as Virginia have caused other varieties of forest trees, such as the evergreen oaks, magnolias, palms, cypress, giant laurels, wild orange, satinwood, mahogany, and mangroves.

The principal trees of these great mixed forests are of the *Deciduous* kind—the maple (*Acer saccharinum* and *A. dasycarpum*), the beech, the elm, ash, oaks, basswood or American linden (*Tilia americana*), chestnut, cherry, butternut, walnut, hickory, poplars, magnolias ; and of the *Coniferæ*—the pines, balsams (*Abies*), tamarac (*Larix americana*), cedars (*Thuja occidentalis*) and (*Juniperus virginiana*), hemlock spruce (*Abies canadensis*).

The most important of these great mixed forests are in Canada, extending from the northern shores of Lake Erie, in lat. 42° , to the northern limits of Canada. Some of these trees have a very extensive range north and south. The sugar maple (*Acer saccharinum*), is found near Lake Winnipeg, in lat. 50° , and the black sugar maple (*A. nigrum*), in lat. 32° , in Louisiana. The beech and elms have a range quite similar to the maple. The American linden also goes as far northward. The white pine (*Pinus Strobus*), prevails in the northern parts of these forests, and the red pine (*P. resinosa*), in the southern. The red cedar (*Juniperus virginiana*), has the greatest range, extending from lat. 26° in Florida to 67° within the arctic circle. The wild cherry, too (*Prunus americana*), a large forest tree, and the shad-bush (*Amelanchier canadensis*), extend over nearly as many degrees. The trembling poplar (*Populus tremu-*

loides), ranges from 37° to 69°. The red current (*Ribes rubrum*), which is found in all the American and Canadian forests, Sir John Richardson discovered growing on the shores of the Arctic Ocean, within the polar circle.

Through all this range of latitude, wherever these deciduous trees are found, these two conditions of climate prevail—high summer temperatures and abundant summer rains; the cold of winter, with the thermometer even at 40° below zero, seeming to produce no effect upon such plants.

On the Colour of the Salmon. By JOHN DAVY, M.D., F.R.S.,
London and Edinburgh, &c.*

All that relates to fish of so much importance as the salmon and its allied species naturally excites our interest. Amongst the many peculiarities of the genus, when the individuals are in their highest condition and best state for the table, is their colour—the colour of their muscles generally—the well-known salmon colour. No other fish that I am aware of, whether in the sea or fresh water, possesses this colour, not even those which are associated with it so often, and the food of which is very similar. Of fresh-water fish, the pike may be mentioned as an example; of salt-water, the *Perca marina*.

On what does this colour depend? Commonly I have heard it attributed to an oil. The circumstance, that the colour is seen only in fish in their highest condition, and that in river and brook-trout it is often absent, seem favourable to this opinion, and the more so, as we know that the same trout which have pale muscles in streams where there is but scanty feed, if removed into ponds or lakes where there is abundance of food, whilst they rapidly increase there in size, acquire also the peculiar hue distinctive of their improved condition. The fact, too, that the salmon loses this colour during its lengthened sojourn in fresh water after spawning, when it becomes lank and out of con-

* Read at the Meeting of the British Association for the Advancement of Science (Newcastle, 1863).

dition, eating during the period, if anything, but very little, seems likewise to favour the opinion. Yet I am doubtful that this opinion is correct, and will bear being inquired into. If an examination be made of the salmon in its highest condition and richest colour, when taken in the sea, or immediately after entering fresh water, what, in relation to colour, are its several parts? Whilst the muscles of the superior section of the body, the thick part, where, comparatively, there is very little fatty or oleaginous matter, exhibits the peculiar colour in perfection, those of the inferior section—the thin portion of the fish—are comparatively pale, and yet there there is a superabundance of oleaginous matter, and of a colourless kind. Moreover, there are certain muscles, those connected with the eyes and the jaws, and the great dorsal fin, which are altogether destitute of the colour in question. Those of the eye, in the midst of cellular tissue, loaded with white adipose matter, are almost colourless. Those of the jaws, where there is very little fatty matter, are of a brownish hue. Those connected with the fin, where, too, there is little fat, are of a dark brown. There is another fact, with the same negative bearing. This is, that the air-bladder of the charr is of a pink colour, often of a beautiful tint (a refinement, as it were, of the salmon-colour, and of the colour of its own muscles), though altogether destitute of oily or fatty matter; and I have seen it thus coloured in fish which, though in good condition, and cutting red, like the salmon, have not been remarkable for richness.

The conclusion I am disposed to come to is, that the salmon-colour is unconnected with oil or fatty matter, and that it belongs to the coloured muscles after the analogy of the colouring of the muscles of various other animals, as witnessed in the instances which come under our observation in the way of meats. In beef, mutton, venison, the hare of proper age, how dark is the muscular fibre. The same colour is seen in the goose, and still more strikingly in the swan, and in most wild birds, and also in certain fishes, especially of the tunny family.

The results of the few chemical experiments which I have made seem to favour the same conclusion. The coloured

muscle of the salmon is rendered paler by the action of a strong solution of ammonia—the aqua ammoniæ—the solution itself remaining colourless. By strong nitric acid it is rendered yellow; by strong sulphuric, brown; by a solution of potash—the liquor potassæ—brown; by strong muriatic acid a slight change of colour is produced; whilst rendered paler, it acquires a brownish tint. Both the strong acids, the nitric and the sulphuric, it may be remarked, and also the solution of potash, have a disorganising, decomposing effect, to which the change of colour they occasion may principally be attributed. Alcohol and ether render the muscle of a lighter hue, but do not deprive it entirely of colour. Both become very slightly coloured, and on cooling and evaporation deposit and leave a colourless liquid oil.

Granting that the colour belongs to the muscular fibre,—*i.e.*, that the colouring matter is seated in the muscle irrespectively of fat,—the further conclusion I would submit is, that it is of an organised kind. It may be a peculiar colouring matter nowise essential to the muscle (some of the muscles, as I have pointed out, being without this colour), and analogous to those colouring matters which exist in plants, especially their leaves and flowers, and in the tegumentary parts of mammalia, birds, and fishes,—such as the hair of the first, the feather of the second, and the epidermis of the third.

Whether the peculiar colour or colouring matter owes its formation to some particular kind of food, or to a special secreting power, I am not aware of any well-marked facts to guide one to a conclusion. So far as probabilities are concerned, I am rather inclined to the belief that it depends partly on the one partly on the other.

Some Observations on the Eggs of Birds. By JOHN DAVY, M.D., F.R.S., Lond. & Edin., &c.*

Although few objects have received more attention from the physiologist and chemist than the egg of the common

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fowl, the eggs of other birds have been much neglected,—indeed, I am not acquainted with any researches that have been published with the intent of ascertaining either the proportions of their constituents, or the qualities of these constituents, from a comparative point of view.

The observations I am about to make, I can offer only as a small contribution to so large a subject,—a subject of especial interest, considering the vast variety of products,—that is, the numerous species of the feathered tribe which are evolved, each distinct, yet as soon as hatched, though developed from similar elements, displaying the form, tastes, and habits characteristic of its kind. I shall first advert to some of the general properties of eggs.

Without exception, the laying birds, whatever their species, when in a healthy state and supplied with a sufficiency of lime, have their eggs enveloped in a resisting shell composed of membranes strengthened by an earthy incrustation, consisting chiefly of carbonate of lime. The thickness of this incrustation in eggs of different birds is very various. It seems to bear some relation to the weight of the incubating bird, and the time of incubation and hatching. Generally, the smaller the bird, and the shorter the period of foetal development, the thinner is the incrustation,—the elasticity of the shell increasing with its diminution of size. I shall give a few instances in illustration, in which, were the thickness carefully measured, it would bear, I believe, a near proportion to the circumstances mentioned,—of each of the following birds, the incubating time is given in days:—

The swan, ...	42 days	The pheasant, . . .	23 days
The common goose, . .	35 „	The red grouse, . .	23 „
The common duck, . .	28 „	Pigeon, ...	14 „
The common fowl, . .	21 „	Turtle-dove, . . .	14 „
The turkey, ...	28 „	Canary bird, . . .	13 „
The guinea-fowl, . .	30-31 „	Wren, ...	10' „
The partridge, . . .	27 „		

These periods are given from such information as I have been able to collect from poulterers, bird-fanciers, and keepers.* They may not be all quite correct, were they

* The time of incubation of the following birds, is copied from H. L. Meyer's

so, the ratio referred to certainly would not be one of perfect exactness. Probably there is another specific element concerned—vital force; thus, though the egg of the bantam is very much smaller than that of the barn-door fowl, yet the same time is required for its hatching.

Whatever the degree of thickness of the shell, it is invariably pervious to air, and chiefly, I believe, through minute apertures—foramina—in the crust. In the egg of the common fowl these are tolerably conspicuous. In every instance that I have put an egg under water deprived of air by the air-pump, on fresh exhaustion air has been seen to rise in currents from particular points, affording proof of the existence of such foramina. Granting their existence, they are certainly covered internally with membrane, through which the air must pass, it may be inferred, by pores of such minuteness as to escape detection under the highest power of the microscope. In a solitary instance, on removing an abortive egg which had been twenty-one days under a hen, on breaking the shell I found it's inner membrane covered in part with mould (*Mucor mucedo*) the spores of which must have entered, it may be presumed, through the foramina in the crust and the insensible pores just referred to.

In accordance with the necessity for the aëration of the embryo and foetus in process of development, the egg of every kind of bird has an air-cell formed by the separation of the two layers of the internal lining membrane, and this at the end which is generally largest, and first presents in the act of being laid. The contained air, in every instance that I have examined it, has been found to differ but little from atmospheric air; and this whatever the age of the egg

“British Birds and their Eggs.” London, 1842.—The Martin (*Hirundo urbica*), from 12 to 13 days; Swift (*H. apus*), 16 to 17; Eagle-owl (*Bubo maximus*), 21; Goshawk (*Astur palumbarius*), 21; Sparrow-hawk (*Accipiter fringillarius*), 21; Stockdove (*Columbo cenas*) 17; Turtledove (*C. turtur*), 16 to 17; Pheasant (*Phasianus colchicus*), 24 to 26; Cock-of-the-wood (*Tetrao urogallus*), 28; Black Grouse (*T. tetrix*), 21; Partridge (*T. perdix*), 21; Swan (*Cygnus olor*), 35 to 42; Wild Duck (*Anas boschas*), 29. The variation as to time, as in the well-known instance of the common fowl, depends probably on the temperature of the atmosphere and the quality of the parent bird, whether a good or bad sitter.

or the time of its incubation,—another proof of the great porosity of the shell and its membranes.

Without any exception yet known, the eggs of all birds consist of albumen and yolk. These in the egg of the common fowl exhibit different and opposite reactions, and different electrical states,—the albumen being alkaline, the yolk acid; and in the instances of the eggs of the smaller birds, I have, as regards the reaction, observed the same; I have had no opportunity to test their electrical condition; but judging from analogy, that also may be inferred to be similar.

I shall now briefly advert to some points of difference. I need hardly notice that of form, and that each kind has commonly a specific shape as well as size, and that though one pole is commonly bigger than the other, the one, as already mentioned, which, in the act of laying, is first protruded, and which contains the air-vesicle, is never, that I am aware of, smaller than its opposite, seemingly a happy provision, securing the successful propulsion of the egg without delay under the influence of an adequate impelling power: did the smaller end first present, it might act as a wedge, and the processes of distension and of laying might be protracted, and the projecting pole in danger.

As is well known, the colour of eggs varies with the species. White may be mentioned as the prevailing colour; next, blue, or bluish-green of different shades; next, brown of different shades, passing into red. Even of the same species, the colour, as of the eggs of the common fowl, is not precisely the same—some being distinguished for their whiteness, as those of the dorking and game-fowl; some for their brown hue, as those of Cochinchina variety. In lustre and polish, too, the several kinds exhibit differences—some having a lustre approaching almost that of the pearl, as the egg of the common pigeon; others being destitute of lustre, giving them a dull appearance. The markings, spots, and partial colouring are so various as to almost baffle description, as any one may satisfy himself by referring to any work in which they are depicted.

These diverse markings—these different colours of eggs—from such experiments as I have made, I am induced to

attribute, not to any mineral colouring matter, but to an organic or animal colouring matter, and that, in part at least, connected with molecular arrangement, analogous to what is witnessed in flowers. As examples, I may give the results of the examination I have made of the dark-brown, almost black, colouring matter of the egg of the common grouse, and of the green of the egg of the starling, and of the green with dark-brown spots, these, too, almost black, of the common thrush. Of all these, the colouring matter has been destroyed before the blowpipe, the shell being rendered perfectly white. In the instance of the thrush's, it is remarkable that, after incandescence, in cooling it recovers in a slight degree its greenish hue, and yet loses it when quite cold; a circumstance this favourable to the idea of the colour, as before remarked, depending in part on molecular arrangement. The green of neither of the eggs is altered by the weak acids, nor by solutions of the alkalies. In strong nitric acid it changes to yellow. In strong muriatic acid it resists change for many hours, fading and disappearing under the continued action of the acid. Chlorine has a similar effect; and bright sunshine, after many days' exposure, renders it fainter: sulphurous acid does not bleach it. On the colour of the grouse's egg strong muriatic acid has no perceptible effect; strong nitric acid changes it to a light dirty yellow. That the colour of this egg is not in any way owing to the presence of iron seemed to be indicated by the following experiment:—A minute portion of blood was applied to the shell; on exposure to the blowpipe, the spot was marked by a slight ochrey stain, the cloured portions becoming, after the destruction of the animal matter, quite white.

The contents, the albumen and yolk, of the several kinds of eggs, though so very similar, are found, even on slight examination, to have points of difference. I shall now restrict myself to three,—viz., the proportional weight of the albumen and yolk, including the shell and its membranes; the density of the two, or rather the proportion of solid matter which each afforded after the dissipation of their aqueous portion by thorough drying; and the effects of heat and its degree in producing the coagulation of the

albumen. I shall give the results, merely premising that in each instance the yolk was separated as much as possible from the white, by rolling it, when that could be done, on a fine linen cloth, stretched; weighing it thus apart, weighing the shell next, after washing it carefully inside and drying it in the air. The weight of the albumen was inferred to be that which was required to complete the weight of the entire egg, previously ascertained. For the sake of comparison, the proportions in the egg of the common fowl, thus examined, may be given:—

1. Egg, newly laid, of a pullet of the *Barn-door fowl*.—Weight 764·5 grs.

			Solid matter, per cent.
Shell and membranes,	78·5 grs., or per cent.,	10·13	
Yolk, ...	192·8 „ „	25·21	55·00
Albumen, ...	493·2 „ „	64·51	10·19

2. *Jay's egg*.—Weight 127·3 grs.

Shell, &c., ...	6·4 grs., or per cent.,	5·03	
Yolk, ...	34·2 „ „	26·86	30·4
Albumen, ...	86·7 „ „	68·11	12·8

The liquid albumen, in a thin glass tube, immersed in water at 169° Fahr., falling to 140°, acquired a slight milky appearance, with little diminution of its fluidity. At 184° falling to 140°, a soft coagulation formed, milk-white and tremulous, hardly bearing inversion. At 195° falling to 80°, the coagulum became somewhat firmer, but much less than the albumen of the common fowl at the same temperature, and it was translucent.

3. *Hedge-Sparrow's*.—Weight, 34·5 grs.

			Solid matter per cent.
Shell, &c.,	2·0 grs., or per cent.,	5·79	
Yolk, .	7·4 „ „	21·45	58·1
Albumen,	25·9 „ „	72·46	12·2

The albumen at 168° falling to 110°, became pretty firmly coagulated; the coagulum was of a distinct greenish hue; transparency but little impaired, nor was it lessened at 212°.

4. *Golden-crested Wren's*.—Of five from the same nest,

the weight of each was as follows: 14·8 grs., 14·4, 14·3, 14·35, 15·2. That which weighed 14·3 grs. was examined.

			Solid matter per cent.
Shell, &c.,	0·7 grs., or per cent.,	4·90	
Yolk, . .	3·44 „ „	24·05	43·6
Albumen, 10·16	„ „	71·05	9·9

One of the eggs was put into water at 200° falling to 140°. On removal of the shell its albumen was found coagulated. The coagulum was soft, semi-transparent, slightly opalescent, and in water had a bluish tinge. The yolk was more firmly coagulated.

5. *Robin's*.—Two were examined; one weighed 38·8 grs., the other 73·8 grs. I believe they were from the same nest.

			Solid matter per cent.
Shell, &c., of the first,	2·1 grs., or per cent.,	5·43	
Yolk, ...	9·4 „ „	24·22	
Albumen, ...	27·3 „ „	70·33	
Shell, &c., of second,	2·0 „ „	2·71	
Yolk, ...	16·3 „ „	22·08	16·5
Albumen, ...	55·5 „ „	75·20	8·2

The albumen of the first at 170° falling to 145°, became of a milky whiteness, with little diminution of fluidity. At 187° falling to 150°, a soft coagulum formed, of the consistence of blanc-mange, and milk-white, nor was it rendered harder by boiling.

6. *Missel-Thrush's*.—Weight of egg, 124·6 grs.

Shell, &c.,	6·4 grs., or per cent.,	5·13
Yolk, . .	16·9 „ „	12·84
Albumen,	101·3 „ „	31·30

The albumen at 169° falling to 148°, had its fluidity slightly impaired, acquiring a slight degree of milkiness. At 179° falling to 150°, a soft coagulum was formed, tremulous, with a bluish hue, and barely admitting of inversion. At 188° falling to 160°, it became firmer, remaining transparent, nor was its transparency destroyed by boiling; even then it was softer than the coagulated white of the hen's egg.

Its yolk at 190° yielded a soft coagulum, which was rendered only a little firmer by boiling.

7. *Starling's*.—Three eggs were obtained from the same nest; one weighed 115·1 grs., another 103·6 grs., the third 102·6 grs. The first of these was examined.

Shell, &c.,	8·2 grs., or per cent.,	7·12
Yolk, .	16·4 „ „	14·25
Albumen,	90·5 „ „	78·62

The yolk of the third egg yielded 45·1 per cent. solid matter; the white, 13·5.

The albumen of No. 1 at 165° falling to 135°, formed a soft milk-white coagulum. Another portion of the same white at 160° falling to 100°, became slightly thickened, flowing on inversion.

8. *Pigeon's egg*.—Weight, 278 grs.

			Solid matter per cent.
Shell, &c.,	22·4 grs., or per cent.,	8·05	
Yolk, .	50·0 „ „	17·94	39·3
Albumen,	205·6 „ „	73·95	11·5

The albumen at 158° falling to 130°, formed a soft coagulum, of a light bluish hue by reflected light, of a wine yellow by transmitted light. At 162° falling to 125°, the consistence of the coagulum was but little increased, it hardly bore inversion without flowing. At 189° falling to 140°, it became much firmer. At 212° it became tougher, scarcely harder, was translucent, and of a bluish hue.

By boiling for an hour the coagulum became transparent, and of a rich brown colour; a similar change is produced in the albumen of the egg of the common fowl, but hardly so strongly marked. On the albumen of the eggs of other birds I have not tried the effects of continued boiling; from analogy it may be inferred that it will be similar.

It may here be worthy of remark that the albumen of all the eggs I have experimented upon, when evaporated to dryness at a temperature below the coagulating point, or allowed to dry slowly in the open air, has always exhibited a symmetrical appearance, not unlike that of the beautiful microscopical object the *Arachneidiscus Ehrenbergii*, this organic-like arrangement evidently depending on the fissures formed from contraction of the solid parts with the loss of its aqueous portion.

The following is a tabular view of the results :—

	Weight.	Shells, &c., per cent.	Yolk, per cent.	White, per cent.	Yolk Solid, per cent.	White, per cent.	Point of Coagulation.	Consistence.	Colour, &c.
Common Fowl's } Egg }	764.5	10.13	25.21	64.5	55.0	10.19	—160°	Hard.	White.
Pigeon's . . . }	278.0	8.05	17.94	73.95	39.3	11.5	—189°	Pretty firm.	Bluish.
Jay's }	127.3	5.03	26.86	68.11	30.0	12.8	—184°	Soft.	{ White, translu- cent.
Missel Thrush's }	124.6	5.53	12.34	81.30	24.3	10.2	—188°	Soft.	Transparent.
Starling's . . . }	115.5	7.12	14.25	78.62	...	...	—195°	Firm.	White.
Robin's }	73.8 38.8	2.71 5.43	22.08 24.22	55.50 70.33	16.5 ...	8.2 ...	—187°	Soft.	White.
Hedge Sparrow's }	34.5	5.79	21.45	72.46	58.1	12.2	—168°	Pretty firm.	{ Greenish, trans- parent.
Golden-crested } Wren's }	14.3	4.90	24.05	43.6	43.6	9.9	.....	Soft.	{ Bluish, semi- transparent.

The differences, as shown by these results, are not great. So far as they allow of inference, they seem to show—1. (as already remarked), That the smaller the egg, the smaller the bird, the shorter the period of incubation, the thinner is the shell, and the more elastic and the smaller the proportion of calcareous incrustation, and in consequence the more pervious to the air, essential to life and development; though even as to this there seems to be no exact ratio, and there appear to be exceptions.*

2. That the albumen in quantity greatly exceeds the yolk, but in no regular proportion; whilst the quantity of solid matter in the yolk is proportionally much larger per cent. than in the albumen.

3. That the temperature at which coagulation takes place varies in almost every instance; and that the firmness of the coagulum does not appear to be regulated by the proportion of solid matter obtained by evaporation.

4. That the coagulum of each has an aspect of its own, varying in the different instances as to kind and degrees of translucency.

Though all the experiments were made with care, I must

* Probably the size of the egg, the quantity of nutritive matter it contains (as suggested in my "Physiological Researches," p. 159), bears some relation to the condition of the young bird on leaving the egg, and its habits, especially as to feeding, *i.e.*, whether it has to find its food after the manner of the offspring of the *Natatores* and *Rasores*, immediately on starting into active life, or is provided with food till fully formed and capable of taking wing, by the parents, after the manner of the *Columbæ*, *Passores*, and *Raptores*.

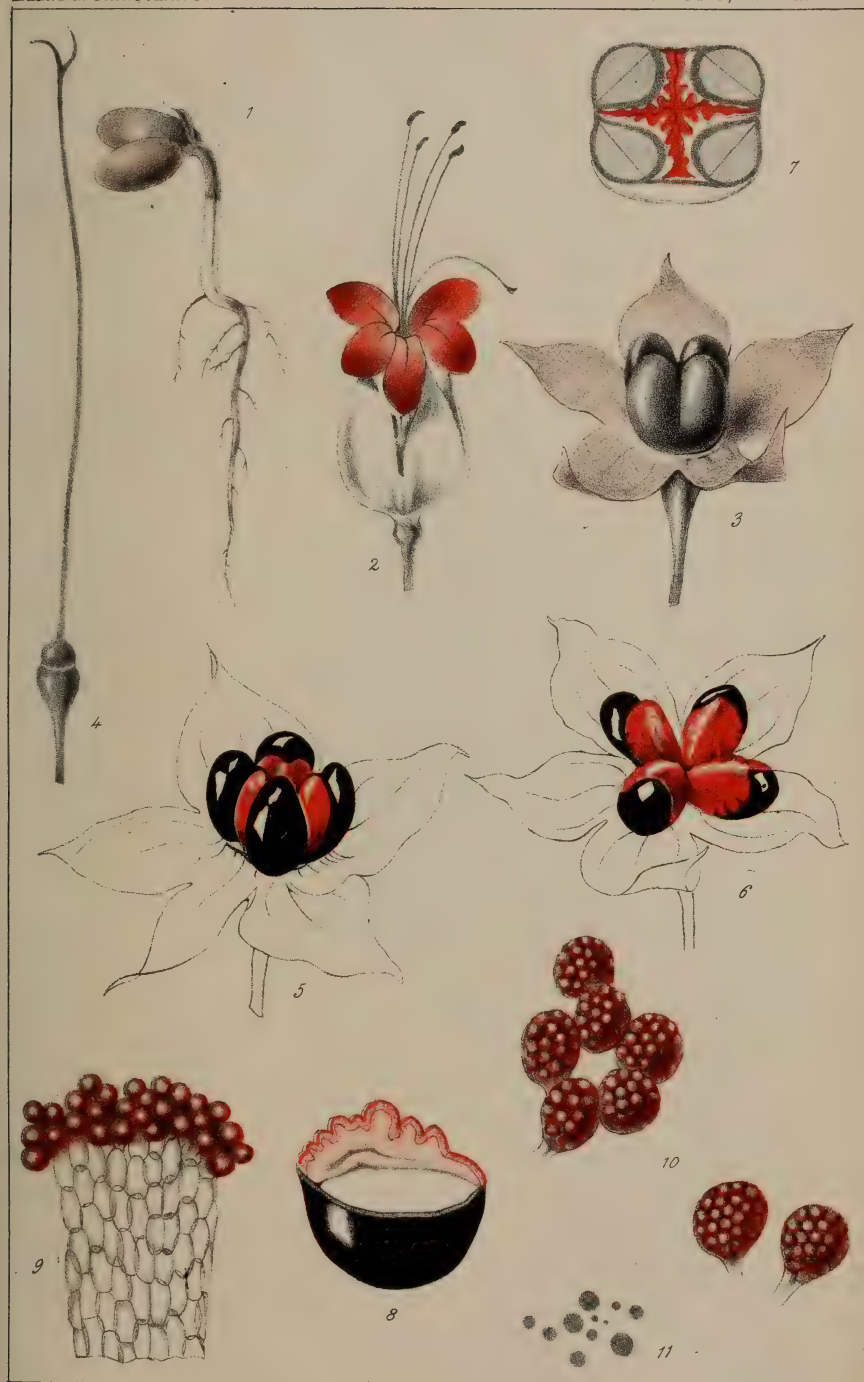
remark, in conclusion, that I can offer their results only as approximations, the sources of error being so many, and of these not the least, the difficulty of ascertaining how long the eggs had been laid. All that I examined, however, appeared to be fresh; none of them bore marks of having been sat on, judging from the total absence of the vascular membrane.*

Description of the Fruit and Seed of Clerodendron Thomsonæ. By Professor BALFOUR. (Plate V.)†

In the Transactions of the Society for 1862, I described a Verbenaceous plant which had been transmitted from Old Calabar by the Rev. W. C. Thomson, and which I named *Clerodendron Thomsonæ*. At that time the plant had flowered (fig. 2) in the Botanic Garden, but it had not perfected fruit. It has now ripened its seeds, and they have germinated in the hot-houses (fig. 1). I therefore complete my description of the species by giving a few details as to the fructification. The style in the young state is terminal, and the four achenes are concrete, so as to appear as a syncarpous tetracarpellary ovary (fig. 4). As the carpels advance in growth they separate, and the style falls off. The young fruit then appears as four green-coloured achenes, partially united and surrounded by the large persistent calyx, which has changed from a white to a pinkish hue (fig. 3). On cutting across the four achenes at their junction, we observe on the inner surfaces a bright red cellular coat (fig. 7). When ripe, the achenes assume a shining black colour externally, and the red cellular covering becomes much enlarged, and by its growth separates the achenes completely, which ultimately appear as four distinct seed-vessels, covered on their upper surface (which

* Those eggs in which this membrane appeared were laid aside. One of these was the Corncrail's; in it the vascular area had just become distinct; its vessels contained florid blood, the corpuscles in which were of an unusual magnitude, some elliptical, some circular without a nucleus; the elliptical of largest size were about $\frac{7}{8} \times \frac{1}{16}$ inch in diameter by $\frac{1}{16} \times \frac{1}{16}$.

† Read before the Botanical Society of Edinburgh, 9th July 1863.



W. H. M. Farlane, Lith. Edin'

Fruit and Seed of *Clerodendron Thomsonæ* (Balf.)



PHOTOGLYPHIC ENGRAVING OF A FERN
H F Talbot



corresponds to their commissure) with a succulent mass of cells of a bright scarlet colour (fig. 5). This mass covers two-thirds of the surface of each achene, and finally assumes an orange colour. The mass exhibits grooves and elevations on its surface, and has a rugose appearance, not unlike the convolutions of the brain (fig. 8). On examining this cellular coat, we find that the scarlet colour is produced by globules apparently of an oily nature, filling the interior of the external cells, and that the cells below are deficient in colour, being clear and transparent (fig. 9). This scarlet succulent mass, increasing very rapidly in the axis, separates the achenes from each other, so that they finally spread out in a cruciate manner, being united only at their bases (fig. 6). The cells of the succulent part of the pericarp are beautiful objects under the microscope, and they are represented in fig. 10. The rapid development of this cellular coat seems almost akin to that in some Fungi, *Bovista* for example, which is one of the marvels of vegetative power. The scarlet colour stains paper beyond remedy; nothing but scratching removes it. The oil-globule-bearing cells look like glands. The minute globules of oil (fig. 11), when pressed out of the cells in water, exhibit molecular movements. When the cells are put into water, the oil globules run together, so as to form a homogeneous mass. The beautiful scarlet covering of the achenes renders the plant scarcely less showy in fruit than it was in flower. (Specimens of the pistil and fruit in various states were exhibited.)

EXPLANATION OF PLATE V.

- Fig. 1. Seed of *Clerodendron Thomsonæ* germinating, showing epigeal cotyledons and radicle.
- Fig. 2. Flower with white-coloured calyx, scarlet corolla, and didynamous stamens.
- Fig. 3. Large calyx surrounding the young fruit, separated into four carpels. The style has fallen off. The calyx is at first white, and finally assumes a pinkish hue.
- Fig. 4. Young pistil, showing terminal style with the four united carpels.
- Fig. 5. Four achenes, with black shining outer coat, and succulent inner covering of a scarlet colour.
- Fig. 6. Four achenes still more separated, apparently by the rapid growth of the scarlet cellular mass at the commissure, which now becomes the upper surface. The achenes arranged in a cruciate manner.

Fig. 7. Young ovary cut across, showing four ovules and scarlet coat in its early development.

Fig. 8. One of the ripe achenes cut transversely, showing the dark episperm on the outside, and the succulent scarlet cellular mass on the inside.

Fig. 9. Coloured cells of the commissure with oil globules, surmounting other cells which are colourless.

Fig. 10. Cells containing scarlet or orange oil-like globules.

Fig. 11. Oil-like globules shown separately.

Proposed Reform of Zoological Nomenclature.

Reform of the Nomenclature of Zoology was a subject which occupied much of the time of the late Hugh E. Strickland.* It was his object that this reform should be brought forward under the auspices of the British Association, and at a meeting of the Council of that body, held in London upon 11th February 1842, it was resolved—"That with a view of securing attention to the following important subject, a committee, consisting of Mr C. Darwin, Professor Henslow, Rev. L. Jenyns, Mr W. Ogilby, Mr J. Phillips, Dr Richardson, Mr H. E. Strickland (reporter), Mr J. O. Westwood, be appointed, to consider of the rules by which the nomenclature of zoology may be established on a uniform and permanent basis; the report to be presented to the Zoological Section, and submitted to its committee at the Manchester meeting."†

This committee met at various times in London, and the following gentlemen were added to it, and assisted in its labours: W. J. Broderip, Professor Owen, W. E. Shuckard, G. R. Waterhouse, and W. Yarrell. An outline of the proposed code of rules was drawn up and circulated, and many valuable suggestions were received from eminent zoologists at home and abroad. The "plan" was farther considered by the committee during the meeting at Manchester, "and the committee having thus given their best endeavours to maturing the plan, beg now to submit it to the approval of the British Association under the title of—'Series of Propositions for rendering the Nomenclature of Zoology uniform and permanent.' "‡

The propositions were printed in the Reports of the British Association, and a grant of money was voted to print copies for

* See Memoirs of Hugh Edwin Strickland, by Sir W. Jardine, Bart., p. clxxv.

† Report of Twelfth Meeting of British Association held at Manchester, June 1842, p. 105.

‡ Report of Twelfth Meeting, 1842, p. 106.

circulation. The rules thus laid down were very generally adopted by zoologists, both in this country and abroad; but having been only printed in the volumes of the British Association, "Annals of Natural History," and "Philosophical Magazine,"* or depending on private circulation only, it was deemed advisable that greater publicity should be given to them, and at the meeting at Oxford in 1860 it was resolved, that "The surviving members of the committee appointed in 1842—viz., Mr C. Darwin, Rev. Professor Henslow, Rev. L. Jenyns, Mr W. Ogilby, Professor Phillips, Sir John Richardson, Mr J. O. Westwood, Professor Owen, Mr W. E. Shuckard, and Mr G. Waterhouse—for the purpose of preparing rules for the establishment of a uniform zoological nomenclature, be re-appointed, with Sir W. Jardine, Bart., and Mr P. L. Slater. That Sir W. Jardine be the Secretary, and that the sum of L.10 be placed at their disposal for the purpose of revising and reprinting the rules."†

From the difficulty of bringing such a committee together, nothing was done since the time of its appointment; but the resolution and the grant of money were again renewed at the late meeting in Newcastle, as follows:—"That Sir W. Jardine, A. R. Wallace, J. E. Gray, C. C. Babington, Dr Francis, P. L. Slater, C. Spence Bate, P. P. Carpenter, Dr J. D. Hooker, Professor Balfour, H. T. Stainton, J. Gwyn Jeffreys, A. Newton, Professor T. H. Huxley, Professor Allman, and Mr Bentham, be a committee, with power to add to their number, to report on the changes which they may consider it desirable to make, if any, in the rules of nomenclature drawn up at the instance of the Association by Mr Strickland and others, with power to reprint these rules, and to correspond with foreign naturalists and others on the best means of insuring their general adoption.—L.15."

Accordingly the rules, as originally circulated, are now re-printed, and zoologists are requested to examine them carefully, and to communicate any suggestions for alteration or improvement, on or before 1st June 1864, to *Sir William Jardine, Bart., Jardine Hall, by Lockerby, N.B.*, who will consult with the members of the committee, and report upon the subject at the next meeting of the British Association appointed to be held at Bath.

Jardine Hall, 8th Sept. 1863.

* At the Scientific Congress held in 1843 at Padua, the late Prince C. L. Buonaparte submitted to the meeting an Italian translation of the "British Association's Code of Rules," which was generally approved of. A French translation of the report appeared in the scientific journal "L'Institut," in which paper much stress was laid on the importance of the measure. A review of it was also printed in the "American Journal of Science."

† Reports of the British Association held at Oxford, 1860, p. xlvii.

Series of Propositions for rendering the Nomenclature of Zoology uniform and permanent.

[Reprinted from the Report of the British Association for 1842.]

PREFACE.

All persons who are conversant with the present state of Zoology must be aware of the great detriment which the science sustains from the vagueness and uncertainty of its nomenclature. We do not here refer to those diversities of language which arise from the various methods of classification adopted by different authors, and which are unavoidable in the present state of our knowledge. So long as naturalists differ in the views which they are disposed to take of the natural affinities of animals there will always be diversities of classification, and the only way to arrive at the true system of nature is to allow perfect liberty to systematists in this respect. But the evil complained of is of a different character. It consists in this, that when naturalists *are* agreed as to the characters and limits of an individual group or species, they still disagree in the appellations by which they distinguish it. A genus is often designated by three or four, and a species by twice that number of precisely equivalent synonyms; and in the absence of any rule on the subject, the naturalist is wholly at a loss what nomenclature to adopt. The consequence is, that the so-called commonwealth of science is becoming daily divided into independent states, kept asunder by diversities of language as well as by geographical limits. If an English zoologist, for example, visits the museums and converses with the professors of France, he finds that their *scientific* language is almost as foreign to him as their *vernacular*. Almost every specimen which he examines is labelled by a title which is unknown to him, and he feels that nothing short of a continued residence in that country can make him conversant with her science. If he proceeds thence to Germany or Russia, he is again at a loss; bewildered everywhere amidst the confusion of nomenclature, he returns in despair to his own country and to the museums and books to which he is accustomed.

If these diversities of scientific language were as deeply rooted as the vernacular tongue of each country, it would of course be hopeless to think of remedying them; but happily this is not the case. The language of science is in the mouths of comparatively few, and these few, though scattered over distant lands, are in habits of frequent and friendly intercourse with each other. All that is wanted, then, is, that some plain and simple regulations, founded on justice and sound reason, should be drawn up by a competent body of persons, and then be extensively distributed throughout the zoological world.

The undivided attention of chemists, of astronomers, of anato-

mists, of mineralogists, has been of late years devoted to fixing their respective languages on a sound basis. Why, then, do zoologists hesitate in performing the same duty? at a time, too, when all acknowledge the evils of the present anarchical state of their science.

It is needless to inquire far into the causes of the present confusion of zoological nomenclature. It is in great measure the result of the same branch of science having been followed in distant countries by persons who were either unavoidably ignorant of each other's labours, or who neglected to inform themselves sufficiently of the state of the science in other regions. And when we remark the great obstacles which now exist to the circulation of books beyond the conventional limits of the states in which they happen to be published, it must be admitted that this ignorance of the writings of others, however unfortunate, is yet in great measure pardonable. But there is another source for this evil, which is far less excusable,—the practice of gratifying individual vanity by attempting, on the most frivolous pretexts to cancel the terms established by original discoverers, and to substitute a new and unauthorised nomenclature in their place. One author lays down as a rule, that no specific names should be derived from geographical sources, and unhesitatingly proceeds to insert words of his own in all such cases; another declares war against names of exotic origin, foreign to the Greek and Latin; a third excommunicates all words which exceed a certain number of syllables; a fourth cancels all names which are complimentary of individuals, and so on, till universality and permanence, the two great essentials of scientific language, are utterly destroyed.

It is surely, then, an object well worthy the attention of the Zoological Section of the British Association for the Advancement of Science to devise some means which may lessen the extent of this evil, if not wholly put an end to it. The best method of making the attempt seems to be, to entrust to a carefully selected committee the preparation of a series of rules, the adoption of which must be left to the sound sense of naturalists in general. By emanating from the British Association, it is hoped that the proposed rules will be invested with an authority which no individual zoologist, however eminent, could confer on them. The world of Science is no longer a monarchy, obedient to the ordinances, however just, of an Aristotle or a Linnæus. She has now assumed the form of a republic, and although this revolution may have increased the vigour and zeal of her followers, yet it has destroyed much of her former order and regularity of government. The latter can only be restored by framing such laws as shall be based in reason, and sanctioned by the approval of men of science; and it is to the preparation of these laws that the Zoological Section of the Association have been invited to give their aid.

In venturing to propose these rules for the guidance of all classes of zoologists in all countries, we disclaim any intention of dictating to men of science the course which they may see fit to pursue. It must of course be always at the option of authors to adhere to or depart from these principles; but we offer them to the candid consideration of zoologists, in the hope that they may lead to sufficient uniformity of method in future to rescue the science from becoming a mere chaos of words.

We now proceed to develop the details of our plan; and in order to make the reasons by which we are guided apparent to naturalists at large, it will be requisite to append to each proposition a short explanation of the circumstances which call for it.

Among the numerous rules for nomenclature which have been proposed by naturalists, there are many which, though excellent in themselves, it is not now desirable to enforce.* The cases in which those rules have been overlooked or departed from are so numerous and of such long standing, that to carry these regulations into effect would undermine the edifice of zoological nomenclature. But while we do not adopt these propositions as authoritative laws, they may still be consulted with advantage in making such additions to the language of zoology as are required by the progress of the science. By adhering to sound principles of philology we may avoid errors in future, even when it is too late to remedy the past, and the language of science will thus eventually assume an aspect of more classic purity than it now presents.

Our subject hence divides itself into two parts; the first consisting of *Rules* for the rectification of the present zoological nomenclature, and the second of *Recommendations* for the improvement of zoological nomenclature in future.

PART I.

RULES FOR RECTIFYING THE PRESENT NOMENCLATURE.

[*Limitation of the Plan to Systematic Nomenclature.*]

In proposing a measure for the establishment of a permanent and universal zoological nomenclature, it must be premised that we refer solely to the Latin or systematic language of zoology. We have nothing to do with vernacular appellations. One great cause of the neglect and corruption which prevails in the scientific nomenclature of zoology, has been the frequent and often exclusive use of vernacular names in lieu of the Latin binomial designa-

* See especially the admirable code proposed in the "*Philosophia Botanica*" of Linnæus. If zoologists had paid more attention to the principles of that code, the present attempt at reform would perhaps have been unnecessary.

tions, which form the only legitimate language of systematic zoology. Let us then endeavour to render perfect the Latin or Linnæan method of nomenclature, which, being far removed from the scope of national vanities and modern antipathies, holds out the only hope of introducing into zoology that grand desideratum, an universal language.

[*Law of Priority the only effectual and just one.*]

It being admitted on all hands that words are only the conventional signs of ideas, it is evident that language can only attain its end effectually by being permanently established and generally recognised. This consideration ought, it would seem, to have checked those who are continually attempting to subvert the established language of zoology by substituting terms of their own coinage. But, forgetting the true nature of language, they persist in confounding the *name* of a species or group with its *definition*; and because the former often falls short of the fulness of expression found in the latter, they cancel it without hesitation, and introduce some new term which appears to them more characteristic, but which is utterly unknown to the science, and is therefore devoid of all authority.* If these persons were to object to such names of men as *Long*, *Little*, *Armstrong*, *Golightly*, &c., in cases where they fail to apply to the individuals who bear them, or should complain of the names *Gough*, *Lawrence*, or *Harvey*, that they were devoid of meaning, and should hence propose to change them for more characteristic appellations, they would not act more unphilosophically or inconsiderately than they do in the case before us; for, in truth, it matters not in the least by what conventional sound we agree to designate an individual object, provided the sign to be employed be stamped with such an authority as will suffice to make it pass current. Now in zoology no one person can subsequently claim an authority equal to that possessed by the person who is the first to define a new genus or describe a new species; and hence it is that the name originally given, even though it may be inferior in point of elegance or expressiveness to those subsequently proposed, ought as a general principle to be permanently retained. To this consideration we ought to add the injustice of erasing the name originally selected by the person to whose labours we owe our first knowledge of the object; and we should reflect how much the permission of such a practice opens a door to obscure pretenders for dragging themselves into notice at the expense of original observers. Neither can an author be permitted to alter a name which he himself has once published, except in accordance with fixed and equitable laws.

* Linnæus says on this subject, "Abstinendum ab hac innovatione quæ nunquam cessaret, quin indies aptiora detegerentur ad infinitum."

It is well observed by Decandolle, "L'auteur même qui a le premier établi un nom n'a pas plus qu'un autre le droit de le changer pour simple cause d'impropriété. La priorité en effet est un terme fixe, positif, qui n'admet rien, ni d'arbitraire, ni de partial."

For these reasons, we have no hesitation in adopting as our fundamental maxim, the "law of priority," viz.,

§ 1. The name originally given by the founder of a group or the describer of a species should be permanently retained, to the exclusion of all subsequent synonyms (with the exceptions about to be noticed.)

Having laid down this principle, we must next inquire into the limitations which are found necessary in carrying it into practice.

[*Not to extend to authors older than Linnæus.*]

As our subject matter is strictly confined to the *binomial system of nomenclature*, or that which indicates species by means of two Latin words, the one generic, the other specific, and as this invaluable method originated solely with Linnæus, it is clear that, as far as species are concerned, we ought not to attempt to carry back the principle of priority beyond the date of the 12th edition of the "Systema Naturæ." Previous to that period, naturalists were wont to indicate species not by a *name* comprised in one word, but by a *definition* which occupied a sentence, the extreme verbosity of which method was productive of great inconvenience. It is true that one word sometimes sufficed for the definition of a species, but these rare cases were only binomial by accident and not by principle, and ought not therefore in any instance to supersede the binomial designations imposed by Linnæus.

The same reasons apply also to generic names. Linnæus was the first to attach a definite value to genera, and to give them a systematic character by means of exact definitions; and therefore, although the *names* used by previous authors may often be applied with propriety to modern genera, yet in such cases they acquire a new meaning, and should be quoted on the authority of the first person who used them in this secondary sense. It is true, that several of the old authors made occasional approaches to the Linnæan exactness of generic definition, but still these were but partial attempts; and it is certain that if in our rectification of the binomial nomenclature we once trace back our authorities into the obscurity which preceded the epoch of its foundation, we shall find no resting-place or fixed boundary for our researches. The nomenclature of Ray is chiefly derived from that of Gesner and Aldrovandus, and from these authors we might proceed backward

to Ælian, Pliny, and Aristotle, till our zoological studies would be frittered away amid the refinements of classical learning.*

We therefore recommend the adoption of the following proposition:—

§ 2. The binomial nomenclature having originated with Linnæus, the law of priority, in respect of that nomenclature, is not to extend to the writings of antecedent authors.

[It should be here explained, that Brisson, who was a contemporary of Linnæus and acquainted with the ‘*Systema Naturæ*,’ defined and published certain genera of birds which are *additional* to those in the twelfth edition of Linnæus’s works, and which are therefore of perfectly good authority. But Brisson still adhered to the old mode of designating species by a sentence instead of a word, and therefore while we retain his defined genera, we do not extend the same indulgence to the titles of his species, even when the latter are accidentally binomial in form. For instance, the *Perdix rubra* of Brisson is the *Tetrao rufus* of Linnæus; therefore as we in this case retain the generic name of Brisson and the specific name of Linnæus, the correct title of the species would be *Perdix rufa*.]

[*Generic names not to be cancelled in subsequent subdivisions.*]

As the number of known species which form the groundwork of zoological science is always increasing, and our knowledge of their structure becomes more complete, fresh generalisations continually occur to the naturalist, and the number of genera and other groups requiring appellations is ever becoming more extensive. It thus becomes necessary to subdivide the contents of old groups, and to make their definitions continually more restricted. In carrying out this process, it is an act of justice to the original author that his generic name should never be lost sight of; and it is no less essential to the welfare of the science, that all which is sound in its nomenclature should remain unaltered amid the additions which are continually being made to it. On this ground we recommend the adoption of the following rule:—

§ 3. A generic name, when once established, should never be cancelled in any subsequent subdivision of the group, but retained in a restricted sense for one of the constituent portions.

[*Generic names to be retained for the typical portion of the old genus.*]

When a genus is subdivided into other genera, the original

* “*Quis longo ævo recepta vocabula commutaret hodie cum patrum?*”—*Linnæus*.

name should be retained for that portion of it which exhibits in the greatest degree its essential characters as at first defined. Authors frequently indicate this by selecting some one species as a fixed point of reference, which they term the "type of the genus." When they omit doing so, it may still in many cases be correctly inferred that the *first* species mentioned on their list, if found accurately to agree with their definition, was regarded by them as the type. A specific name, or its synonyms, will also often serve to point out the particular species which by implication must be regarded as the original type of a genus. In such cases we are justified in restoring the name of the old genus to its typical signification, even when later authors have done otherwise. We submit therefore that

§ 4. The generic name should always be retained for that portion of the original genus which was considered typical by the author.

Example.—The genus *Picumnus* was established by Temminck, and included two groups, one with four toes, the other with three, the *former* of which was regarded by the author as typical. Swainson, however, in raising these groups at a later period to the rank of genera, gave a new name, *Asthenurus*, to the *former* group, and retained *Picumnus* for the *latter*. In this case we have no choice but to restore the name *Picumnus*, Temm., to its correct sense, cancelling the name *Asthenurus*, Sw., and imposing a new name on the 3-toed group which Swainson had called *Picumnus*.

[When no type is indicated, then the original name is to be kept for that subsequent subdivision which first received it.]

Our next proposition seems to require no explanation:—

§ 5. When the evidence as to the original type of a genus is not perfectly clear and indisputable, then the person who first subdivides the genus may affix the original name to any portion of it at his discretion, and no later author has a right to transfer that name to any other part of the original genus.

[A later name of the same extent as an earlier to be wholly cancelled.]

When an author infringes the law of priority by giving a new name to a genus which has been properly defined and named already, the only penalty which can be attached to this act of negligence or injustice, is to expel the name so introduced from the pale of the science. It is not right, then, in such cases to

restrict the meaning of the later name so that it may stand side by side with the earlier one, as has sometimes been done. For instance, the genus *Monaulus*, Vieill. 1816, is a precise equivalent to *Lophophorus*, Temm. 1813, both authors having adopted the same species as their type, and therefore, when the latter genus came in the course of time to be divided into two, it was incorrect to give the condemned name *Monaulus* to one of the portions. To state this succinctly,

§ 6. When two authors define and name the same genus, both making it exactly of the same extent, the later name should be cancelled *in toto*, and not retained in a modified sense.*

This rule admits of the following exception :—

§ 7. Provided however, that if these authors select their respective types from different sections of the genus, and these sections be afterwards raised into genera, then both these names may be retained in a restricted sense for the new genera respectively.

Example—The names *Ædemia* and *Melanetta* were originally co-extensive synonyms, but their respective types were taken from different sections which are now raised into genera, distinguished by the above titles.

[No special rule is required for the cases in which the later of two generic names is so defined as to be *less extensive* in signification than the earlier, for if the later includes the type of the earlier genus, it would be cancelled by the operation of § 4; and if it does not include that type, it is in fact a distinct genus.]

But when the later name is *more extensive* than the earlier, the following rule comes into operation :—

[*A later name equivalent to several earlier ones is to be cancelled.*]

The same principle which is involved in § 6 will apply to § 8.

§ 8. If the later name be so defined as to be equal in extent to two or more previously published genera, it must be cancelled *in toto*.

Example.—*Psarocolius*, Wagl. 1827, is equivalent to five or six genera previously published under other names, therefore *Psarocolius* should be cancelled.

If these previously published genera be *separately adopted* (as

* These discarded names may, however, be *tolerated*, if they have been afterwards proposed in a totally new sense, though we trust that in future no one will *knowingly* apply an old name, whether now adopted or not, to a new genus. (See proposition *q. infra*.)

is the case with the equivalents of *Psarocolius*), their original names will of course prevail; but if we follow the later author in combining them into one, the following rule is necessary:—

[*A genus compounded of two or more previously proposed genera whose characters are now deemed insufficient, should retain the name of one of them.*]

It sometimes happens that the progress of science requires two or more genera, founded on insufficient or erroneous characters, to be combined together into one. In such cases the law of priority forbids us to cancel *all* the original names and impose a *new* one on this compound genus. We must therefore select some one species as a type or example, and give the generic name which it formerly bore to the whole group now formed. If these original generic names differ in date, the oldest one should be the one adopted.

§ 9. In compounding a genus out of several smaller ones, the earliest of them, if otherwise unobjectionable, should be selected, and its former generic name be extended over the new genus so compounded.

Example.—The genera *Accentor* and *Prunella* of Vieillot not being considered sufficiently distinct in character, are now united under the general name of *Accentor*, that being the earliest. So also *Cerithium* and *Potamides*, which were long considered distinct, are now united, and the latter name merges into the former.

We now proceed to point out those few cases which form exceptions to the law of priority, and in which it becomes both justifiable and necessary to alter the names originally imposed by authors.

[*A name should be changed when previously applied to another group which still retains it.*]

It being essential to the binomial method to indicate objects in natural history by means of *two words* only, without the aid of any further designation, it follows that a generic name should only have one meaning,—in other words, that two genera should never bear the same name. For a similar reason, no two species in the same genus should bear the same name. When these cases occur, the later of the two duplicate names should be cancelled, and a new term, or the earliest synonym, if there be any, substituted. When it is necessary to form new words for this purpose, it is desirable to make them bear some analogy to those which they are destined to supersede, as where the genus of birds

Plectorhynchus, being preoccupied in Ichthyology, is changed to *Plectorhamphus*. It is, we conceive, the bounden duty of an author, when naming a new genus, to ascertain by careful search that the name which he proposes to employ has not been previously adopted in other departments of natural history.* By neglecting this precaution he is liable to have the name altered and his authority superseded by the first subsequent author who may detect the oversight, and for this result, however unfortunate, we fear there is no remedy, though such cases would be less frequent if the detectors of these errors would, as an act of courtesy, point them out to the author himself, if living, and leave it to him to correct his own inadvertencies. This occasional hardship appears to us to be a less evil than to permit the practice of giving the same generic name *ad libitum* to a multiplicity of genera. We submit, therefore, that

§ 10. A name should be changed which has before been proposed for some other genus in zoology or botany, or for some other species in the same genus, when still retained for such genus or species.

[*A name whose meaning is glaringly false may be changed.*]

Our next proposition has no other claim for adoption than that of being a concession to human infirmity. If such proper names of places as Covent Garden, Lincoln's Inn Fields, Newcastle, Bridgewater, &c., no longer suggest the ideas of gardens, fields, castles, or bridges, but refer the mind with the quickness of thought to the particular localities which they respectively designate, there seems no reason why the proper names used in natural history should not equally perform the office of correct indication, even when their etymological meaning may be wholly inapplicable to the object which they typify. But we must remember that the language of science has but a limited currency, and hence the words which compose it do not circulate with the same freedom and rapidity as those which belong to every-day life. The attention is consequently liable in scientific studies to be diverted from the contemplation of the thing signified to the etymological meaning of the sign, and hence it is necessary to provide that the latter shall not be such as to propagate actual error. Instances of this kind are indeed very rare, and in some cases, such as that of *Monodon*, *Caprimulgus*, *Paradisea apoda* and *Monoculus*, they have acquired sufficient currency no longer to cause error, and are therefore retained without change. But when we find a Batrachian reptile named in violation of its true affinities *Mastodon saurus*, a

* This laborious and difficult research will in future be greatly facilitated by the very useful work of M. Agassiz, entitled "Nomenclator Zoologicus."

Mexican species termed (through erroneous information of its habitat) *Picus cafer*, or an olive-coloured one *Muscicapa atra*, or when a name is derived from an accidental monstrosity, as in *Picus semirostris* of Linnæus, and *Helix disjuncta* of Turton, we feel justified in cancelling these names, and adopting that synonym which stands next in point of date. At the same time we think it right to remark, that this privilege is very liable to abuse, and ought therefore to be applied only to extreme cases and with great caution. With these limitations we may concede that

§ 11. A name may be changed when it implies a false proposition which is likely to propagate important errors.

[*Names not clearly defined may be changed.*]

Unless a species or group is intelligibly defined when the name is given, it cannot be recognised by others, and the signification of the name is consequently lost. Two things are necessary before a zoological term can acquire any authority, viz., *definition* and *publication*. Definition properly implies a distinct exposition of essential characters, and in all cases we conceive this to be indispensable, although some authors maintain that a mere enumeration of the component species, or even of a single type, is sufficient to authenticate a genus. To constitute *publication*, nothing short of the insertion of the above particulars *in a printed book* can be held sufficient. Many birds, for instance, in the Paris and other continental museums, shells in the British Museum (in Dr Leach's time), and fossils in the Scarborough and other public collections, have received MS. names which will be of no authority until they are published.* Nor can any unpublished descriptions, however exact (such as those of Forster, which are still shut up in a MS. at Berlin), claim any right of priority till published, and then only from the date of their publication. The same rule applies to cases where groups or species are published, but not defined, as in some museum catalogues, and in Lesson's "*Traité d'Ornithologie*," where many species are enumerated by name, without any description or reference by which they can be identified. Therefore,—

§ 12. A name which has never been clearly defined in some published work should be changed for the earliest name by which the object shall have been so defined.

[*Specific names, when adopted as generic, must be changed.*]

The necessity for the following rule will be best illustrated by

* These MS. names are in all cases liable to create confusion, and it is therefore much to be desired that the practice of using them should be avoided in future.

an example. The *Corvus pyrrhonorax*, Linn., was afterwards advanced to a genus under the name of *Pyrrhonorax*. Temminck adopts this generic name, and also retains the old specific one, so that he terms the species *Pyrrhonorax pyrrhonorax*. The inelegance of this method is so great as to demand a change of the specific name, and the species now stands as *Pyrrhonorax alpinus*, Vieill. We propose, therefore, that

§ 13. A new specific name must be given to a species when its old name has been adopted for a genus which includes that species.

N.B.—It will be seen, however, below, that we strongly object to the further continuance of this practice of elevating specific names into generic.

[*Latin orthography to be adhered to.*]

On the subject of orthography it is necessary to lay down one proposition,—

§ 14. In writing zoological names, the rules of Latin orthography must be adhered to.

In Latinizing Greek words there are certain rules of orthography known to classical scholars which must never be departed from. For instance, the names which modern authors have written *Aipunemia*, *Zenophasia*, *poioccephala*, must, according to the laws of etymology, be spelt *Æpyncnemia*, *Xenophasia*, and *pæocephala*. In Latinizing modern words the rules of classic usage do not apply, and all that we can do is to give to such terms as classical an appearance as we can, consistently with the preservation of their etymology. In the case of European words whose orthography is fixed, it is best to retain the original form, even though it may include letters and combinations unknown in Latin. Such words, for instance, as *Woodwardi*, *Knighti*, *Bullocki*, *Eschscholtzi*, would be quite unintelligible if they were Latinized into *Vudvardi*, *Cnichti*, *Bulloci*, *Essolzi*, &c. But words of barbarous origin, having no fixed orthography, are more pliable, and hence, when adopted into the Latin, they should be rendered as classical in appearance as is consistent with the preservation of their original sound. Thus the words *Tochus*, *awsuree*, *argoondah*, *kundoo*, &c., should, when Latinized, have been written *Toccus*, *ausure*, *argunda*, *cundu*, &c. Such words ought, in all practicable cases, to have a Latin termination given them, especially if they are used generically.

In Latinizing proper names, the simplest rule appears to be to use the termination *-us*, genitive *-i*, when the name ends with a

consonant, as in the above examples; and *-ius*, gen. *-ii*, when it ends with a vowel, as *Latreille*, *Latreillii*, &c.

In converting Greek words into Latin the following rules must be attended to:—

Greek.	Latin.	Greek.	Latin.
α becomes	α .	θ becomes	th.
ϵ „	i.	ϕ „	ph.
$\omicron$ terminal,	us.	χ „	ch.
υ „	um.	κ „	c.
$\omicron$ becomes	u.	$\gamma\chi$ „	nch.
ω „	ω .	$\gamma\gamma$ „	ng.
υ „	y.	„	h.

When a name has been erroneously written and its orthography has been afterwards amended, we conceive that the authority of the original author should still be retained for the name, and not that of the person who makes the correction.

PART II.

RECOMMENDATIONS FOR IMPROVING THE NOMENCLATURE IN FUTURE.

The above propositions are all which, in the present state of the science, it appears practicable to invest with the character of laws. We have endeavoured to make them as few and simple as possible, in the hope that they may be the more easily comprehended and adopted by naturalists in general. We are aware that a large number of other regulations, some of which are hereafter enumerated, have been proposed and acted upon by various authors who have undertaken the difficult task of legislating on this subject; but as the enforcement of such rules would in many cases undermine the invaluable principle of priority, we do not feel justified in adopting them. At the same time we fully admit that the rules in question are, for the most part, founded on just criticism, and therefore, though we do not allow them to operate retrospectively, we are willing to retain them for future guidance. Although it is of the first importance that the principle of priority should be held paramount to all others, yet we are not blind to the desirableness of rendering our scientific language palatable to the scholar and the man of taste. Many zoological terms, which are now marked with the stamp of perpetual currency, are yet so far defective in construction, that our inability to remove them without infringing the law of priority may be a subject of regret. With these terms we cannot interfere, if we adhere to the principles above laid down; nor is there even any remedy, if authors

insist on infringing the rules of good taste by introducing into the science words of the same inelegant or unclassical character in future. But that which cannot be enforced by law may, in some measure, be effected by persuasion; and with this view we submit the following propositions to naturalists, under the title of *Recommendations for the Improvement of Zoological Nomenclature in future.*

[*The best names are Latin or Greek characteristic words.*]

The classical languages being selected for zoology, and words being more easily remembered in proportion as they are expressive, it is self-evident that

§ A. The *best* zoological names are those which are derived from the Latin or Greek, and express some distinguishing characteristic of the object to which they are applied.

[*Classes of objectionable names.*]

It follows from hence that the following classes of words are more or less objectionable in point of taste, though, in the case of *genera*, it is often necessary to use them, from the impossibility of finding characteristic words which have not before been employed for other genera. We will commence with those which appear the least open to objection, such as

a. Geographical names.—These words being for the most part adjectives can rarely be used for *genera*. As designations of *species* they have been so strongly objected to, that some authors (Wagler, for instance) have gone the length of substituting fresh names wherever they occur; others (*e.g.* Swainson) will only tolerate them where they apply *exclusively*, as *Lepus hibernicus*, *Trogodytes europæus*, &c. We are by no means disposed to go to this length. It is not the less true that the *Hirundo javanica* is a Javanese bird, even though it may occur in other countries also, and though other species of *Hirundo* may occur in Java. The utmost that can be urged against such words is, that they do not tell the *whole truth*. However, as so many authors object to this class of names, it is better to avoid giving them, except where there is reason to believe that the species is chiefly confined to the country whose name it bears.

b. Barbarous names.—Some authors protest strongly against the introduction of exotic words into our Latin nomenclature, others defend the practice with equal warmth. We may remark, first, that the practice is not contrary to classical usage, for the Greeks and Romans did occasionally, though with reluctance, introduce barbarous words in a modified form into their respective languages. Secondly, the preservation of the trivial names which

animals bear in their native countries is often of great use to the traveller in aiding him to discover and identify species. We do not therefore consider, if such words have a Latin termination given to them, that the occasional and judicious use of them as scientific terms can be justly objected to.

c. *Technical names*.—All words expressive of trades and professions have been by some writers excluded from zoology, but without sufficient reason. Words of this class, *when carefully chosen*, often express the peculiar characters and habits of animals in a metaphorical manner, which is highly elegant. We may cite the generic terms, *Arvicola*, *Lanius*, *Pastor*, *Tyrannus*, *Regulus*, *Mimus*, *Ploceus*, &c., as favourable examples of this class of names.

d. *Mythological or historical names*.—When these have no perceptible reference or allusion to the characters of the object on which they are conferred, they may be properly regarded as unmeaning and in bad taste. Thus the generic names, *Lesbia*, *Leilus*, *Remus*, *Corydon*, *Pasiphæ*, have been applied to a Humming bird, a Butterfly, a Beetle, a Parrot, and a Crab respectively, without any perceptible association of ideas. But mythological names may sometimes be used as generic with the same propriety as technical ones, in cases where a direct allusion can be traced between the narrated actions of a personage and the observed habits or structure of an animal. Thus when the name *Progne* is given to a Swallow, *Clotho* to a Spider, *Hydra* to a Polyp, *Athene* to an Owl, *Nestor* to a grey-headed Parrot, &c., a pleasing and beneficial connection is established between classical literature and physical science.

e. *Comparative names*.—The objections which have been raised to words of this class are not without foundation. The names, no less than the definitions of objects, should, where practicable, be drawn from positive and self-evident characters, and not from a comparison with other objects, which may be less known to the reader than the one before him. Specific names expressive of comparative size are also to be avoided, as they may be rendered inaccurate by the after discovery of additional species. The names *Picoides*, *Emberizoides*, *Pseudoluscinia*, *rubeculoides*, *maximus*, *minor*, *minimus*, &c., are examples of this objectionable practice.

f. *Generic names compounded from other genera*.—These are in some degree open to the same imputation as comparative words; but as they often serve to express the position of a genus as intermediate to, or allied with, two other genera, they may occasionally be used with advantage. Care must be taken not to adopt such compound words as are of too great length, and not to corrupt them in trying to render them shorter. The names *Gallopavo*,

Tetraogallus, *Gypaetos*, are examples of the appropriate use of compound words.

g. Specific names derived from persons.—So long as these complimentary designations are used with moderation, and are restricted to persons of eminence as scientific zoologists, they may be employed with propriety in cases where expressive or characteristic words are not to be found. But we fully concur with those who censure the practice of naming species after persons of no scientific reputation, as curiosity-dealers (e. g. *Caniveti*, *Boissoneauti*), Peruvian priestesses (*Cora*, *Amazilia*), or Hottentots (*Klassi*).

h. Generic names derived from persons.—Words of this class have been very extensively used in botany, and therefore it would have been well to have excluded them wholly from zoology, for the sake of obtaining a *memoria technica* by which the name of a genus would at once tell us to which of the kingdoms of nature it belonged. Some few personal generic names have, however, crept into zoology, as *Cuvieria*, *Mulleria*, *Rossia*, *Lessonia*, &c., but they are very rare in comparison with those of botany, and it is perhaps desirable not to add to their number.

i. Names of harsh and inelegant pronunciation.—These words are grating to the ear, either from inelegance of form, as *Huhua Yuhina*, *Craxirex*, *Eschscholtzi*, or from too great length, as *chirostrongylostinus*, *Opetiorhynchus*, *brachypodioides*, *Thecodontosaurus*, not to mention the *Enaliolimnosaurus crocodilocephaloides* of a German naturalist. It is needless to enlarge on the advantage of consulting euphony in the construction of our language. As a general rule it may be recommended to avoid introducing words of more than five syllables.

k. Ancient names of animals applied in a wrong sense.—It has been customary, in numerous cases, to apply the names of animals found in classic authors at random to exotic genera or species which were wholly unknown to the ancients. The names *Cebus*, *Callithrix*, *Spiza*, *Kitta*, *Struthus*, are examples. This practice ought by no means to be encouraged. The usual defence for it is, that it is impossible now to identify the species to which the name was anciently applied. But it is certain that if any traveller will take the trouble to collect the vernacular names used by the modern Greeks and Italians for the Vertebrata and Mollusca of southern Europe, the meaning of the ancient names may in most cases be determined with the greatest precision. It has been well remarked that a Cretan fisher boy is a far better commentator on Aristotle's 'History of Animals' than a British or German scholar. The use however of ancient names, *when correctly applied*, is most desirable, for "in framing scientific

terms, the appropriation of old words is preferable to the formation of new ones.”*

l. Adjective generic names.—The names of genera are in all cases essentially substantive, and hence adjective terms cannot be employed for them without doing violence to grammar. The generic names *Hians*, *Criniger*, *Cursorius*, *Nitidula*, &c., are examples of this incorrect usage.

m. Hybrid names.—Compound words, whose component parts are taken from two different languages, are great deformities in nomenclature, and naturalists should be especially guarded not to introduce any more such terms into zoology, which furnishes too many examples of them already. We have them compounded of Greek and Latin, as *Dendrofalco*, *Gymnocorvus*, *Monoculus*, *Arborophila flavigaster*; Greek and French, as *Jacamaralcyon*, *Jacamerope*; and Greek and English, as *Bullockoides*, *Gilbertsocrinites*.

n. Names closely resembling other names already used.—By Rule 10 it was laid down, that when a name is introduced which is *identical* with one previously used, the later one should be changed. Some authors have extended the same principle to cases where the later name, when correctly written, only approaches in form, without wholly coinciding with, the earlier. We do not, however, think it advisable to make this law imperative, first, because of the vast extent of our nomenclature, which renders it highly difficult to find a name which shall not bear more or less resemblance in sound to some other; and, secondly, because of the impossibility of fixing a limit to the degree of approximation beyond which such a law should cease to operate. We content ourselves, therefore, with putting forth this proposition merely as a recommendation to naturalists, in selecting generic names, to avoid such as too closely approximate words already adopted. So with respect to species, the judicious naturalist will aim at variety of designation, and will not, for example, call a species *virens* or *virescens* in a genus which already possesses a *viridis*.

o. Corrupted words.—In the construction of compound Latin words, there are certain grammatical rules which have been known and acted on for two thousand years, and which a naturalist is bound to acquaint himself with before he tries his skill in coining zoological terms. One of the chief of these rules is, that in compounding words all the radical or essential parts of the constituent members must be retained, and no change made except in the variable terminations. But several generic names have been lately introduced which run counter to this rule, and

* Whewell, *Phil. Ind. Sc.* v. i. p. lxvii.

form most unsightly objects to all who are conversant with the spirit of the Latin language. A name made up of the first half of one word and the last half of another, is as deformed a monster in nomenclature as a Mermaid or a Centaur would be in zoology; yet we find examples in the names *Corcorax* (from *Corvus* and *Pyrrhocorax*), *Cypsnagra* (from *Cypselus* and *Tanagra*), *Merulaxis* (*Merula* and *Synallaxis*), *Loxigilla* (*Loxia* and *Fringilla*), &c. In other cases, where the commencement of both the simple words is retained in the compound, a fault is still committed by cutting off too much of the radical and vital portions, as is the case in *Bucorvus* (from *Buceros* and *Corvus*), *Ninox* (*Nisus* and *Noctua*), &c.

p. *Nonsense names.*—Some authors having found difficulty in selecting generic names which have not been used before, have adopted the plan of coining words at random without any derivation of meaning whatever. The following are examples: *Viralva*, *Xema*, *Azeca*, *Assiminia*, *Quedius*, *Spisula*. To the same class we may refer *anagrams* of other generic names, as *Dacelo* and *Cedola* of *Alcedo*, *Zapornia* of *Porzana*, &c. Such verbal trifling as this is in very bad taste, and is especially calculated to bring the science into contempt. It finds no precedent in the Augustan age of Latin, but can be compared only to the puerile quibblings of the middle ages. It is contrary to the genius of all languages, which appear never to produce new words by spontaneous generation, but always to derive them from some other source, however distant or obscure. And it is peculiarly annoying to the etymologist, who, after seeking in vain through the vast storehouses of human language for the parentage of such words, discovers at last that he has been pursuing an *ignis fatuus*.

q. *Names previously cancelled by the operation of § 6.*—Some authors consider that when a name has been reduced to a synonym by the operations of the laws of priority, they are then at liberty to apply it at pleasure to any new group which may be in want of a name. We consider, however, that when a word has once been proposed in a given sense, and has afterwards sunk into a synonym, it is far better to lay it aside for ever than to run the risk of making confusion by re-issuing it with a new meaning attached.

r. *Specific names raised into generic.*—It has sometimes been the practice in subdividing an old genus to give to the lesser genera so formed, the names of their respective typical species. Our Rule 13 authorizes the forming a new specific name in such cases; but we further wish to state our objections to the practice altogether. Considering as we do that the original specific names should as far as possible be held sacred, both on the grounds of justice to their authors and of practical convenience to naturalists,

we would strongly dissuade from the *further continuance* of a practice which is gratuitous in itself, and which involves the necessity of altering long established specific names.

We have now pointed out the principal rocks and shoals which lie in the path of the nomenclator; and it will be seen that the navigation through them is by no means easy. The task of constructing a language which shall supply the demands of scientific accuracy on the one hand, and of literary elegance on the other, is not to be inconsiderately undertaken by unqualified persons. Our nomenclature presents but too many flaws and inelegancies already, and as the stern law of priority forbids their removal, it follows that they must remain as monuments of the bad taste or bad scholarship of their authors to the latest ages in which zoology shall be studied.

[*Families to end in idæ, and Subfamilies in inæ.*]

The practice suggested in the following proposition has been adopted by many recent authors, and its simplicity and convenience is so great that we strongly recommend its universal use.

§ B. It is recommended that the assemblages of genera termed *families* should be uniformly named by adding the termination *idæ* to the name of the earliest known, or most typically characterized genus in them; and that their subdivisions, termed *subfamilies*, should be similarly constructed, with the termination *inæ*.

These words are formed by changing the last syllable of the genitive case into *idæ* or *inæ*, as *Strix*, *Strigis*, *Strigidæ*, *Buceros*, *Bucerotis*, *Bucerotidæ*, not *Strixidæ*, *Buceridæ*.

[*Specific names to be written with a small initial.*]

A convenient *memoria technica* may be effected by adopting our next proposition. It has been usual, when the titles of species are derived from proper names, to write them with a capital letter, and hence when the specific name is used alone it is liable to be occasionally mistaken for the title of a genus. But if the titles of *species* were *invariably* written with a *small* initial, and those of *genera* with a *capital*, the eye would at once distinguish the rank of the group referred to, and a possible source of error would be avoided. It should be further remembered that all species are *equal*, and should therefore be written all *alike*. We suggest, then, that

§ C. Specific names should *always* be written with a small initial letter, even when derived from persons or places, and generic names should be always written with a capital.

[The authority for a species, exclusive of the genus, to be followed by a distinctive expression]

The systematic names of zoology being still far from that state of fixity which is the ultimate aim of the science, it is frequently necessary for correct indication to append to them the name of the person on whose authority they have been proposed. When the same person is authority both for the specific and generic name, the case is very simple; but when the specific name of one author is annexed to the generic name of another, some difficulty occurs. For example, the *Muscicapa crinita* of Linnæus belongs to the modern genus *Tyrannus* of Vieillot; but Swainson was the first to apply the specific name of Linnæus to the generic one of Vieillot. The question now arises, Whose authority is to be quoted for the name *Tyrannus crinitus*? The expression *Tyrannus crinitus*, Linn., would imply what is untrue, for Linnæus did not use the term *Tyrannus*; and *Tyrannus crinitus*, Vieill., is equally incorrect, for Vieillot did not adopt the name *crinitus*. If we call it *Tyrannus crinitus*, Sw., it would imply that Swainson was the first to describe the species, and Linnæus would be robbed of his due credit. If we term it *Tyrannus*, Vieill., *crinitus*, Linn., we use a form which, though expressing the facts correctly, and therefore not without advantage in particular cases where great exactness is required, is yet too lengthy and inconvenient to be used with ease and rapidity. Of the three persons concerned with the construction of a binomial title in the case before us, we conceive that the author who *first* describes and names a species which forms the groundwork of later generalisations, possesses a higher claim to have his name recorded than he who afterwards defines a genus which is found to embrace that species, or who may be the mere accidental means of bringing the generic and specific names into contact. By giving the authority for the *specific* name in preference to all others, the inquirer is referred *directly* to the original description, habitat, &c., of the species, and is at the same time reminded of the date of its discovery; while genera, being less numerous than species, may be carried in the memory, or referred to in systematic works without the necessity of perpetually quoting their authorities. The most simple mode then for ordinary use seems to be, to append to the original authority for the species, when not applying to the genus also, some distinctive mark, such as (*sp.*), implying an exclusive reference to the *specific* name, as *Tyrannus crinitus* (Linn.) (*sp.*), and to omit this expression when the same authority attaches to both genus and species, as *Ostrea edulis*, Linn.* Therefore,

* The expression *Tyrannus crinitus* (Linn.) would perhaps be preferable from its greater brevity.

§ D. It is recommended that the authority for a specific name, *when not applying to the generic name also*, should be followed by the distinctive expression (*sp.*)

[*New genera and species to be defined amply and publicly.*]

A large proportion of the complicated mass of synonyms which has now become the opprobrium of zoology, has originated either from the slovenly and imperfect manner in which species and groups have been originally defined, or from their definitions having been inserted in obscure local publications which have never obtained an extensive circulation. Therefore, although under § 12, we have conceded that mere insertion in a printed book is sufficient for *publication*, yet we would strongly advise the authors of new groups always to give, in the first instance, a full and accurate definition of their characters, and to insert the same in such periodical or other works as are likely to obtain an immediate and extensive circulation. To state this briefly,

§ E. It is recommended that new genera or species be *amply* defined, and *extensively* circulated in the first instance.

[*The names to be given to subdivisions of genera to agree in gender with the original genus.*]

In order to preserve specific names as far as possible in an unaltered form, whatever may be the changes which the genera to which they are referred may undergo, it is desirable, when it can be done with propriety, to make the new subdivisions of genera agree *in gender* with the old groups from which they are formed. This recommendation does not, however, authorise the changing the gender or termination of a genus already established. In brief,

§ F. It is recommended that in subdividing an old genus in future, the names given to the subdivisions should agree in gender with that of the original group.

[*Etymologies and types of new genera to be stated.*]

It is obvious that the names of genera would in general be far more carefully constructed, and their definitions would be rendered more exact, if authors would adopt the following suggestion:—

§ G. It is recommended that in defining new genera the etymology of the name should be always stated, and that one species should be invariably selected as a type or standard of reference.

In concluding this outline of a scheme for the rectification of zoological nomenclature, we have only to remark, that almost

the whole of the propositions contained in it may be applied with equal correctness to the sister science of botany. We have preferred, however, in this essay to limit our views to zoology, both for the sake of rendering the question less complex, and because we conceive that the botanical nomenclature of the present day stands in much less need of distinct enactment than the zoological. The admirable rules laid down by Linnæus, Smith, Decandolle, and other botanists (to which, no less than to the works of Fabricius, Illiger, Vigors, Swainson, and other zoologists, we have been much indebted in preparing the present document), have always exercised a beneficial influence over their disciples. Hence the language of botany has attained a more perfect and stable condition than that of zoology; and if this attempt at reformation may have the effect of advancing zoological nomenclature beyond its present backward and abnormal state, the wishes of its promoters will be fully attained.

(Signed)	H. E. STRICKLAND.	J. S. HENSLOW.
	JOHN PHILLIPS.	W. E. SUCKHARD.
	JOHN RICHARDSON.	G. R. WATERHOUSE.
	RICHARD OWEN.	W. YARRELL.
	LEONARD JENYNS.	C. DARWIN.
	W. J. BRODERIP.	J. O. WESTWOOD.

June 27, 1842.

PROCEEDINGS OF SOCIETIES.

*British Association for the Advancement of Science, held at
Newcastle, August 1863.*

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

President—Professor W. J. MACQUORN RANKINE.

“Report of the Committee on Electrical Standards.” By Mr FLEEMING JENKIN.—The Committee report that the system of so-called absolute electrical units, based on purely mechanical measurements, is the only system consistent with our present knowledge, both of the relations existing between the various electrical phenomena, and of the connection between these and the fundamental measurements of time, mass, and space. The doubts felt as to the accuracy with which this system could be reduced to practice have been dispelled by the success of experiments made for the Committee by Prof. Maxwell, Mr Stewart, and Mr Jenkin on the measurement of the absolute resistance of a conductor, by a method due to Prof. W. Thomson. Standard resistance coils will shortly be issued based on these experiments, which will, however, be repeated, with entirely new data, before this final step is taken, so as to avoid every chance

of error. The other electrical measurements in the absolute system offer comparatively little difficulty.

“Researches on the Moon.” By Prof. PHILLIPS.—The author having on previous occasions presented his views as to the methods and objects of research in the moon, was desirous now to state a few results, and exhibit a few drawings, the fruit of recent examinations of the moon by means of a new equatorial by Cooke, with an object-glass of 6 inches. In sketching ring mountains, such as Theophilus and Posidonius, the author has been greatly interested by the changes of aspect which even a small alteration in the angles of elevation and azimuth respectively produce in the shadow and lights. Taking an example from Cyrillus, with its rocky interior, and fixing attention on the nearly central mountain, it always appears in the morning light to have two principal unperforated masses. By a slight change in the direction of the light, the division of these masses is deeply shaded on the north or deeply shaded on the south, and the figure of the masses, *i.e.* the limit of light and shade, seems altered. A slight change in the angle of elevation of the incident light makes more remarkable differences. On Posidonius, which is a low, nearly level plateau, within moderately raised borders, the mid morning light shows with beautiful distinctness the shield-like disc of the mountain, with narrow broken walls, and in the interior, broad, easy undulations, one large and several smaller craters. In earlier morning more craters appear, and the interior ridges gather to form a broken terrace subordinate to the principal ridge. This circumstance of an interior broken terrace, under the high main ring of mountain, is very frequent, but it is often concealed by the shadow of the great ridge in early morning shadows. To see it emerge into half-lights, and finally to distinct digitations and variously directed ridges, as the light falls at increasing angles, is a very beautiful sight. But it is chiefly to the variations in the central masses of lunar mountains and their physical bearings that the author wishes to direct attention. Many smaller mountains are simply like cups set in saucers, while others contain only one central or several dispersed cups. In Plato is a nearly central very small cup, bright, and giving a distinct shadow on the grey ground, as seen by Mr Lockyer, Mr Birt, and Professor Phillips himself. But in the centre of many of the larger mountains, as Copernicus, Gassendi and Theophilus, is a large mass of broken rocky country, 5,000 or 6,000 feet high, with buttresses passing off into collateral ridges, or an undulated surface of low ridges and hollows. The most remarkable object of this kind which the author has yet observed with attention is in Theophilus, of which mountain two drawings are given, in which the author places equal confidence, except that the later drawing may have the advantage of more experience. The central mass is seen under powers of 200–400 (the best performance is from 200 to 300), and appears as a large conical mass of rocks about fifteen miles in diameter, and divided by deep chasms radiating from the centre. The rock-masses between these deep clefts are bright and shining, the clefts widen towards the centre, the eastern side is more diversified than the western, and like the southern side has long excurrent buttresses. As the light grows on the mountain, point after point of the mass on the eastern side comes out of the shade, and the whole figure resembles an uplifted mass which broke with radiating cracks in the act of elevation. Excepting in steepness, this resembles the theoretical Mont d’Or of De Beaumont; and as there is no mark of cups or craters in this mass of broken ground the author is disposed to regard its origin as really due to the displacement of a solidified part of the moon’s crust. He might be justified by Prof. Secchi’s drawing of Copernicus, in inquiring if the low excurrent buttresses may

indicate issues of lava on the southern and western sides? On the whole, the author is confirmed in the opinion he has elsewhere expressed, that on the moon's face are features more strongly marked than on our own globe, which, rightly studied, may lead to a knowledge of volcanic action under grander and simpler conditions than have prevailed on the earth during the period of subaërial volcanoes. The author also exhibited a drawing of Aristarchus, showing some undescribed features in the aspect of that, the highest part of the moon's surface.

"On Sun Spots and their Connection with Planetary Configuration." By Mr BALFOUR STEWART.—The author of this note having recently found in the course of conversation with Prof. P. G. Tait of Edinburgh, that they had both, independently, and by different trains of reasoning, been led to suspect the existence of a new principle in Natural Philosophy, which, however, must of course stand or fall by appeal to experiment and observation,—it fell to his lot to endeavour to ascertain if there be any connection between sun-spots and planetary configurations. In a preliminary inquiry with this object in view, he was led to observe the changes with regard to size which take place in sun-spots, from a remark by Mr Beckley of Kew Observatory, that, during a certain period, he did not observe any spots *break out* on the visible disc of our luminary. Besides about six months' records of these phenomena, made by means of the Kew photoheliograph at the Kew Observatory, the author has had the opportunity of investigating a year's records made by the same instrument at Mr De La Rue's private Observatory at Cranford. All of these are collodion negatives, and besides embracing a few months in the end of 1859, they give an almost continuous record of the state of the sun's disc between February 1862 and the present date. There is little difficulty in finding from these, by means of a comparison of two or three consecutive pictures, approximately, at what portion of the sun's disc any spot ceases to increase and begins to wane, or, on the other hand, breaks out into a visible appearance. Now it appears to be a law nearly universal, that if we divide the disc of the sun roughly into longitude by vertical diameters, and if there be a number of spots on the surface of the sun, these will all behave in the same manner as they cross the same longitude; that is to say, if one spot decreases another will decrease also, and so on. This law can, of course, be only approximately ascertained by means of a preliminary examination of this nature; but the impression produced upon the author is very strong, that if one spot decreases before coming to the central line, another does the same; if, on the other hand, one spot breaks out on the right half and increases up to the border, another will do the same. The author thinks, moreover, that he has noticed a connection between this behaviour of sun-spots, and the configuration of the nearer planets, Mercury and Venus, and it would seem to be of this nature. Remembering that all motions are from left to right, let us suppose that Mercury and Venus are both in a line considerably to the left of the Earth; then spots will decrease as they come round from the left-hand side, and before they reach the centre of the disc. On the other hand, if these two planets are considerably to the right of the Earth, there will be a tendency for spots to form on the right half of the disc, and to increase up to the border. The author would, however, guard himself against the supposition that he attributes all the phenomena of spots to the agency of these two planets.

"On the Path of a Meteoric Fireball relatively to the Earth's Centre." By Prof. COFFIN.

"On the changing Colours of the Star 95 Herculis." By Prof. C.
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PIAZZI SMYTH.—The star 95 Herculis is a double star, of which the two members are nearly of equal magnitude, about the 5th, and are six seconds apart, in R.A. 17h. 55' 33" and D 21° 25' 56" in 1860. It has hitherto been catalogued as a diversely coloured pair of stars to an extreme degree, one member being called "apple green" and the other "cherry red." These colours have moreover been looked upon, as are the colours of all ordinary stars, as constant features sensibly. Being observed, however, by the author, when he was on the peak of Teneriffe, in 1856, they were found nearly colourless, and without any diversity of tint, the one from the other. This observation appears to have been considered anomalous, and was so to a certain extent; but on examining older authorities the author has met with two other instances of an equality of pale colour being observed on the two components of 95 Herculis—one by Sestini, in 1844-5, and the other by Struve in 1832-53; and remarks that while these two epochs are separated by twelve years exact to a tenth, the latter of them precedes the Teneriffe observation in 1856-58 by almost exactly the same quantity. Now this looks like a regular periodic change, and in a very short period, for it is not improbable but that the twelve years is a multiple of a shorter period still, and during which the change of tint of the stars is so marked that from being merely grey at a certain time, one star has been described as becoming an "astonishing yellow green," and the other "an egregious red." Although this is the first instance of this kind yet detected in the sky, the author thinks that it will not be found a solitary one; and that its phenomena may bear some relation to the "eclipse" pink prominences of our sun, and to auroral displays about the earth.

"On a New Revolving Scale for Measuring Curved Lines." By Mr H. SCHLAGINTWEIT.—This instrument consisted of a small brass wheel revolving in a short handle, the circumference about two inches round, having a number of very short steel pins inserted radially, the number depending on the scale to which it was desired to measure the curve; and the side of the wheel having graduations corresponding to the pins on the circumference, the zero and other remarkable divisions being distinguished from the lesser graduations.

"On some Phenomena produced by the Refractive Power of the Eye." By Mr A. CLAUDET.—This paper was to explain several effects of the refraction through the eye, one of which is, that objects situated a little behind us, are seen as if they were on a straight line from right to left. Another, that the pictures of external objects which are represented on the retina, are included in an angle much larger than one-half of the sphere at the centre of which the observer is placed; from this point of view a single glance encompasses a vast and splendid panorama extending to an angle of 200°. This is the result of the common law of refraction.

Mr B. S. PROCTOR read a paper "On the Focal Adjustment of the Eye."

M. CLAUDET exhibited his "Star Chromatoscope," a small telescope fixed upon a stand, and revolving. It is used to observe stars, and the effect produced is, that on looking through the instrument a luminous ring is seen reflecting the particular colour or colours of the star observed.

Dr AKIN read a paper "On the Transmutation of Spectral Rays," including some curious speculations on the luminosity of the sun and stars.

The Abbé MOIGNO exhibited and explained the "Tenebroscope" invented by M. Soleil to illustrate the principle of the invisibility of light. The Abbé humorously observed that this term was somewhat of an Irishism, but nevertheless it was a fact that light is quite invisible, for celestial space

was perfectly dark until the appearance of a celestial body, and then it became perfectly illuminated.

The instrument is formed in the manner of a common spy-glass, with a break in the centre of the tube to admit light. Below is a spring, with a small ivory ball attached. The observer looks through one end of the instrument and sees that all is dulness; but when the spring is raised, the space becomes illuminated with light, showing that the introduction of the ball is necessary to render the light visible.

Professor C. PIAZZI SMYTH then entered into a history and explanation of the time-signals.

“On a Printing-Telegraph.” By Professor D. E. HUGHES.—This instrument possesses special merits not only for land lines, but for long sub-marine lines, from the fact of its requiring but one wave to each letter, and the sensitiveness and simplicity of the electrical arrangements. The following rates of speed were obtained in different lengths of cables:—

Atlantic cable, ...	2500 miles,	4 words per minute.
Red Sea, do., ...	2000	6
Do. do., ...	1000	10
Do. do., ...	500	24
Denmark do., ...	360	22
Tasmania do., ...	240	30

On aerial lines the average speed of good operators is forty words per minute.

Mr W. Cook read a paper on the Printing-Telegraph invented by M. le Chevallier Bonelli (the former Director of Telegraph in Italy), in which the messages are printed by means of types.—The telegraph transmitted a message in six seconds, and it was quite possible to work it at a long distance.

Mr W. LADD exhibited a new form of Syren, adapted for the lecture-table, to illustrate acoustics and harmony.

Mr LADD exhibited an acoustic telegraph for the transmission of musical notes and sounds between distant points, this ingenious contrivance being the invention of a schoolmaster at Frankfort, whom Mr Ladd had met with in his travels.

Mr LADD also exhibited a small electromotive engine, constructed by himself on a new principle, and calculated to lift a weight of twenty-two lbs. eight inches per minute.

Professor CHEVALLIER introduced a new series of numbers, invented by Mr R. S. Browne, for expressing the distances between the planets.

Professor C. W. SIEMENS read a paper “On the Electrical Resistance and the Electrification of India-rubber under a pressure of 300 tons,” detailing experiments he had made with the Malta and Alexandria submarine cable, &c.—The Professor explained that, as Mr Jenkin had previously discovered that electrification is not influenced by temperature, so his own experiments went to show that it was not affected by pressure; but the latter exercised this abnormal influence on these materials, that it increased the resistance in gutta percha, but decreased it in India-rubber.

“Report on Luminous Meteors.” By Mr J. GLAISHER.

“Description of a Solar Eye-piece,” made by the Rev. Mr Dawes, F.R.A.S. By Dr LEE.—The peculiarity of the instrument consisted in having a metallic slide, with perforations of different sizes, which crossed the eye-tube at right angles, just at the focus of the object-glass, and

though the slide would become greatly heated while viewing the sun, the conduction was cut off by interposing a plate of ivory.

"On the Relationship between the Variation of the Earth's Eccentricity and that of the Moon's Mean Motion in Longitude." By Dr HINCKS.

"On the Connection that exists between Admiral Fitzroy's 'Caution Telegrams' and the Luminosity of Phosphorus." By Dr MOFFAT.

"Report of Balloon Committee." By Dr LEE.

"Report on Balloon Ascents." By Mr J. GLAISHER.

"On the Selenographical Relations between the Chain of Lunar Mountains 'the Alps,' with the 'Mare Imbrium,' and the 'Mare Frigoris.'" By Mr W. R. BIRT.

Professor CHEVALLIER described a New Instrument for Ascertaining the Height of a Cloud by taking the Measure of the Shadow Projected—the instrument being formed something like a "two-foot rule" with an upright piece attached.

"On the Distribution of Heat on the Sun's Surface, and the Currents of his Atmosphere." By Mr J. J. MURPHY.

"On Ozone, more especially on Ozone Tests." By Mr E. J. LOWE.

"Comparisons of Curves afforded by Self-recording Magnetographs at Kew and Lisbon." By Mr BALFOUR STEWART.

"Description of the Experimental Series of Rain-Gauges erected at Calne." By Mr G. J. SYMONS.

"Meteorological Observations." By Rev. J. RANKINE.

"On a New Kind of Miniature, possessing Apparent Solidity by Means of a Combination of Prisms." By Mr H. SWAN.

Dr LEE read a paper descriptive of certain Mountains and Craters in the Moon, discovered by himself and Mr Birt. One they had named "Mare Smythii," in honour of Professor C. Piazzi Smyth. Another portion of the lunar landscape had been named "the Phillips Walled Plain," in honour of Professor Phillips, who had bestowed much attention on the physical features of the lunar surface. Thirdly, they had given to an elevated range the name of the "Percy Mountains," in compliment to His Grace the Duke of Northumberland, who had been the only nobleman to go through a complete course of university study of three years in astronomy. The Duke had also rendered the important service of presenting to the University of Cambridge their large Northumberland Telescope.

"On the System of Forecasting the Weather pursued in Holland." By Dr BUYS BALLOT.

"Account of Preliminary Experiments on Chalcescence." By Dr AKIN.

"On Spectral Analysis." By Professor PLUCKER.

"On Specific Refractive Energy." By Dr GLADSTONE and Mr Dale.

"On the Quantity and Centre of Gravity of Figures given in Perspective, or Homography." By Professor SYLVESTER.

"On the Augmentation of the Apparent Diameter of a Body by Atmospheric Refraction." By Mr S. ALEXANDER.

"On the Conditions of the Resolvability of Homogeneous Algebraical Polynomials into Factors." By Mr J. J. WALKER.

"On the Elasticity of the Vapour of Sulphuric Acid." By Mr T. TATE.

"On the Result of Reductions of Curves obtained from the Self-recording Electrometer at Kew." By Professor W. THOMSON.

"On the Mathematical Theory of Plane Water Lines." By Professor RANKINE.

"On a certain class of Mathematical Symbols." By Mr W. H. RUSSELL.

"On a Mercurial Air-Pump." By Mr J. SWAN.

L'Abbé MOIGNO exhibited the following instruments:—A Free Air Barometer, by the Abbé Jeannon; a Metallic or Holosteric Barometer, by M. Naudet; a New Micrometer, by M. H. Soleil.

L'Abbé MOIGNO also exhibited Specimens of Telegraphic Facsimiles, produced by Casselli's method.

L'Abbé MOIGNO communicated a paper by M. Oudry on Galvanic Copper and its Applications.

"On a New Marine Barometer, and on a Maximum Thermometer with a New Scale." By Mr W. SYMONS.

"Interim Report on the Vertical Motion of Currents of Air." By Professor HENESSY.

"On the Proof of the Dioptric and Actinic Quality of the Atmosphere at a High Elevation." By Professor PIAZZI SMYTH.

SECTION B.—CHEMICAL SCIENCE.

President—Professor A. W. WILLIAMSON.

"On Fire-Clay Goods." By Mr J. COWEN, jun.—Fire-clay is obtained in large quantities in the two counties of Durham and Northumberland. It usually lies beneath the Coal Measures in layers, varying in thickness from twelve inches to five or six feet. It is found in most abundance, and in the best quality, beneath the coal used for coking and manufacturing purposes. Silica and alumina are the two substances of which fire-clay is chiefly composed.

The trade in fire-clay goods is of comparatively recent origin. Its progress at first was slow, but during the last forty years it has extended rapidly, and is still on the increase. The extension during the last twenty-five years has been especially marked and important. Fire-bricks were first made on the Tyne about one hundred years ago.

For many years all that were made were consumed in the manufactories in the neighbourhood. Slowly but gradually the trade increased, and the goods made were sent in larger or smaller quantities to different parts of the United Kingdom, and to some of the chief ports in Europe and the British colonies. The extent of the trade in 1838 was as follows:—The number of bricks manufactured at that time per annum was about 7,000,000. The local consumption then was about 2,500,000. The quantity sent to other parts of the United Kingdom was about 3,000,000, and the quantity exported was about 1,500,000. The extent of the trade at the present time is as follows:—

Number of Fire-bricks made per annum about 80,000,000

The local consumption is estimated at 43,000,000

The quantity sent to other parts of the United Kingdom is estimated at..... } 27,500,000

And the quantity exported 9,500,000

“On Glass.” By Mr R. W. SWINBURNE.—The art of casting plate glass by throwing the molten material on an iron or copper table, and rolling it into a sheet of equal thickness, was first adopted in England, in Lancashire, in 1771; but there is abundant-proof that plate glass of smaller dimensions was made before that time at South Shields, where is situated the only manufactory of plate glass in this district. In the early part of the seventeenth century, an article called blown plate glass was made at that place, and the manufacture was continued by the family who originally established it until 1845, when the process was abandoned, being entirely superseded by the cast plate. In this is afforded an instance of the superiority of machinery over manual labour. Blown plate glass, which was the great original of the art in all countries, depended entirely in its manipulation on the strength of lungs and dexterity of muscle of the individual operator, whose *chef-d'œuvre* was about four feet long and two and a half feet wide, whereas the cast is made by the co-operative efforts of twenty men, who move from the furnace the crucible in which the material is melted, and by means of powerful machinery roll it into a plane of any required dimensions. The record of the daily manufacture of blown plate glass at South Shields, in 1750, is still extant, and affords a curious proof of the infancy of the art and of the difficulties of the operator. Up to the year 1845, the returns of the Excise duty show that there was more plate glass made at South Shields than at any other manufactory in the kingdom. In that year the Excise duty on glass was abrogated, and in consequence the produce of this manufactory has been quadrupled. Previously to 1845, the quantity of unpolished plate glass blown and cast at South Shields was 312,000 feet per annum: now its capability of produce is 1,240,000 feet per annum. A new kind of plate glass, called rolled plate, has been for some time manufactured at Sunderland, by the spirited firm of Messrs Hartley & Co. The invention is due to Mr James Hartley, who has had the honour of establishing a new branch of manufacture of great public utility. This new article somewhat resembles unpolished plate glass, but is lighter in substance and eminently fitted for roofing and other purposes of construction where translucency only is required.

“On Earthenware.” By Mr C. T. MALING.—The manufacture of white earthenware was introduced into this district by Mr Warburton, at Carr’s Hill Pottery, near Gateshead, about 1730 or 1740. Those works were very successfully carried on for seventy years, when they gradually declined, and in 1817 were closed; a small portion of the building is still used as a brown-ware pottery. The next manufactory was built by Mr Byers, at Newbattle, in the county of Durham, about 1755, where brown and white earthenware still continue to be made. There are now about twenty-five potteries in this district, of which, on the Tyne, six manufacture white and printed ware; four, white, printed, and brown ware; and three brown ware only—employing 1200 people, and manufacturing, yearly, about 12,000 tons of white clay, and 3000 tons of brown clay, and consuming in the process of manufacture about 34,000 tons of coals. On the Wear, there are two potteries manufacturing white and printed ware; two white, printed, and house ware; and two brown ware only—employing about 500 people, manufacturing yearly about 4000 tons of white clay, 1500 tons of brown clay, and consuming in the manufacture about 14,000 tons of coals. On the Tees there are four potteries, manufacturing white and printed ware, employing 500 people, manufacturing 5000 tons of white clay, and consuming 13,000 tons of coals. The description of goods manufactured in this district is that used by the middle and working

classes, no first-class goods being made here. The principal markets, in addition to the local trade, are the Danish, Norwegian, German, Mediterranean, and London, for exportation to the colonies. The trade to the United States being so very small from here, the American war has affected this district less than any other.

“On the Presence of a Salt of Baryta in Colliery Water.” By Dr T. RICHARDSON.

“On the Oxidation of (β) Hexylic Alcohol.” By Professor WANKLYN.

“On some Results of Experiments on Lucifer Matches and others ignited by Friction.” By Professor ABEL.—Having mentioned the components, which chiefly consisted of ordinary phosphorus and gum or glue as a binding material, he went on to notice the possible causes of accident in the transport of matches. The result of experiments proved that no degree of heat to which, under all ordinary circumstances, matches were likely to be exposed in their transport or otherwise, would suffice to lead to their spontaneous ignition. It was quite within the range of possibility, however, that on board ship continuous concussion, combined with a degree of heat, might bring about accidental ignition of matches, while it might be granted that the accidental ignition of one or two boxes in securely-closed cases might frequently occur almost without a possibility of fear of it spreading to other boxes. A knowledge of the causes of the accidental ignition of gunpowder and other explosives rendered it advisable that such precautionary measures as were obvious and easily observed should be attended to in the shipment of matches, with the view of reducing such occurrences to the minimum extent. Some of those steps he specified. The *first* was the appropriation of a place for the reception of such packages, distinct from all other merchandise. *Secondly*, The efficient ventilation of that part of the vessel in which matches were stowed. *Thirdly*, The enforcement of rules to prevent fire being brought by sailors within the vicinity of the matches. *Fourthly*, The carefully packing of the match-boxes into cases, so as to prevent any independent motion. And, *fifthly*, The bestowal of more uniform attention on the production of stout and sufficiently stable match-boxes.

Dr PAUL believed a considerable proportion of the matches now used were dipped with parafine—a substitute for the sulphur that was originally used, and the resinous coating that had been applied to them. The effect was very advantageous. Parafine matches ignited readily. There was no smell from them, and they were otherwise preferable.

“On a New Gas Furnace for Scientific and Practical Purposes.” By Mr G. GORE.

“On Disinfectants.” By Mr H. B. CONDY.

“Report of the Committee on Gun-Cotton.”—Dr GLADSTONE read the chemical portion of the report. It stated that during the year the committee had been put in possession of the fullest information on the subject, by Baron William Von Leuk, Major-General of the Austrian Artillery, who was the inventor of the system by which gun-cotton was made available for warlike purposes; and Professor Abel, chemist of the War Department, by permission of the Secretary of State for War, had communicated to them the information given by the Austrian Government to the Government of this country. The committee had made no experiments themselves. The subject might naturally be divided into two conditions—the chemical and mechanical. Taking the chemical first, that department included the manufacture of the gun-cotton itself, its liability or non-liability to spontaneous combustion, and

the nature and effects of the products into which it was resolved on explosion. As to the chemical nature of the material itself, the gun-cotton differed from the gun-cotton generally made, in its complete conversion into a uniform chemical compact. General Leuk secured the production of his gun-cotton by several precautions. Of these the most important were, the cleansing and perfect dessication of the cotton as a preliminary to its immersion in the acid; the employment of the strongest acids obtainable in commerce; the steeping of the cotton in a fresh strong mixture of acids, after its first immersion and consequent imperfect conversion into gun-cotton; the continuance of this steeping for forty-eight hours. Equally necessary is the thorough purification of the gun-cotton so produced from every trace of free acid. There is one part of the process of the manufacture, the value of which is not open to doubt—viz., the treatment of the gun-cotton with a solution of silicate of potash, commonly called water-glass. The chief advantages of the material were set forth in the mechanical report, but it was here stated that the fact that gun-cotton is not injured by damp like gunpowder, is one of its recommendations, while a still greater chemical advantage which it possesses arises from its being perfectly resolved into gases on explosion, so that there is no smoke to obscure the sight of the soldier who is firing, or to point out his position to the enemy, and no residue left in the gun to be got rid of before another charge can be introduced.

Mr SCOTT RUSSELL, F.R.S., submitted the mechanical report. After a long and careful examination, the committee were able to understand and reconcile themselves to the fact that greater mechanical effects are produced from gases generated by gun-cotton than by those generated by gunpowder. The same quantity of gases and the same number of atmospheres seemed to be produced from both materials, and it did not appear to mechanical men that there was a greater advantage in gun-cotton in that respect. The next inquiry was into the distinctive nature between the action of these gases in gunpowder and the action of those gases in gun-cotton. The great waste of force in gunpowder constituted an important difference between it and the gun-cotton, in which there was no waste. Gunpowder consisted of about 68 per cent. of solid matter, only 32 of which was useful gases. It might be seen, therefore, that one-third of gunpowder is not directly useful in producing gases. There was another peculiar feature of gun-cotton—it could be exploded in any quantity instantaneously. General Leuk had discovered the means of giving gun-cotton any velocity of explosion that is required by merely the mechanical arrangement under which it is used. Gunpowder in his hands had any speed of explosion, from one foot per second, to one in 1000th of a second, or to instantaneity. The spontaneous explosion of a large quantity of gun-cotton is made use of when it is required to produce destructive effects, and it is found that the condition necessary to produce instantaneous combustion is the absolute perfection of the closeness of the chamber containing the gun-cotton. On the other hand, if they desired gun-cotton to produce a different effect, they must provide for its slower combustion. It must be opened out mechanically, so as to occupy a large space, and in this state it can be made to act even more slowly than gunpowder, and the limits for the purposes of artillery. In general it is found that the proportion of 111lbs. of gun-cotton occupying one cubic foot of space, produce a greater force than gunpowder, and a force of the nature required for ordinary artillery. But each gun and each kind of projectile requires a certain density of cartridge. Practically, gun-cotton is most effective in guns, when used as a quarter to one-third

weight of powder, and occupying a space of one and one-tenth of the length of the powder cartridge. In regard to safety, it was a fact that during the ten years of the manufacture of General Leuk's gun-cotton at the imperial factory at Kirtenberg, and during ten years' storage of that material in the imperial magazines at Steinfeldt, in which thousands of cwts. were deposited, not one single accident occurred. The best temperature for gun-cotton was 136 centigrade, or between 277 and 338 Fahrenheit—a temperature sufficiently high to ensure safety for all practical purposes. The cost of production was considerably less than that of gunpowder, the price and quantities being compared which will produce equal effects. As to the mechanical purposes of the cotton, it is used for artillery in the form of gun-cotton thread or spun-yarn. In this simple form, it would conduct combustion slowly in the open air at the rate of not more than one second. This thread was woven into a texture or circular web. These webs were made of various diameters, and out of them cotton rifle cartridges were made by cutting them into the proper length. The cotton web was generally enclosed in India-rubber tubes, in which form it is most convenient. For the explosion of mines it is used in the form of ropes. *Conveyance and Storage of Gun-Cotton.*—One pound of gun-cotton produces effects somewhat exceeding 3 lbs. of gunpowder in artillery. This is a material advantage, whether it be carried by men, by horses, or in waggons. It may be placed in a store and preserved with great safety. The danger from explosion does not arise until it is confined. It may become damp, and even perfectly wet, and, without injury, may be dried by mere exposure to the air. *Practical Use in Artillery.*—The gun keeps clean, and requires less windage, and therefore performs much better in continuous firing. In gunpowder there is 68 per cent. of refuse, or the matter of fouling. In gun-cotton there is no residuum, and therefore no fouling. Experiments made by the Austrian committee proved that 100 lbs. could be fired with gun-cotton against 30 lbs. of gun-powder. From the low temperature produced by gun-cotton, the gun does not heat. Experiments showed that 100 lbs. were fired with a 6-pounder in thirty-four minutes, and the heat was raised by gun-cotton to only 122 degrees of Fahrenheit; whilst 100 lbs. of gunpowder took 100 minutes, and raised the temperature to such a degree that water was instantly evaporated. The firing with the gunpowder was therefore discontinued, but the rapid firing with the gun-cotton was continued up to 180 lbs. without any inconvenience. The absence of fouling allows the mechanism of a gun to have more exactness than where allowance is made for fouling. The absence of smoke permits rapid firing and exact time. The fact of smaller recoil from a gun-charged with gun-cotton is established by direct experiments. Its value is two-thirds of the recoil from gun-powder, the projectile being equal. *Practical Application to Destructive Explosion.*—It is ascertained that the same shell is exploded by the same volume of gas generated from gun cotton and gun-powder into more than double the number of pieces; and it is a startling fact, that the stronger and thicker the shell the smaller and more numerous are the fragments. *Mining Uses.*—The fact that the action of the gun-cotton is violent and rapid in exact proportion to the resistance it encounters, tells us the secret of the far higher efficacy of gun-cotton in mining than gun-powder. The stronger the rock, the less gun-cotton comparatively with gun-powder is found necessary for the effect—so much so that while gun-cotton is stronger than gun-powder, weight for weight, as three to one in artillery, it is stronger in the proportion 6·27 to that of strong solid rock, weight for weight. It is

the hollow rope form which is used for blasting. Its power in splitting up material is exerted exactly as you wish. With regard to the military and submarine explosion, it is a well-known fact that a bag of gun-powder nailed on the gates of a city will blow them open. A bag of cotton exploded in the same way produces no effect. To blow up the gates of a city with gun-cotton, it must be confined before explosion. Twenty pounds of gun-cotton carried in the hands of a single man would be sufficient, only he must know its value.

“On Chemical Manufactures on the Tyne.” By Mr J. C. STEVENSON.
—The manufactures included Salt, Soda Ash, Caustic Soda, Hyposulphite of Soda, Manganese, French Limestone, Bleaching Powder, Soap, Prussiate of Potash, Alum, Epsom Salts, Carbonate of Magnesia, Superphosphate of Lime, Pearl Hardening, Sulphate of Iron, Venetian Red, Sulphate of Copper, Resin Size, Lamp Black, Grease.

QUANTITIES AND PRICES.—RAW MATERIALS.

	Tons.	Price.	Value.		
Sulphur (included as Pyrites)...	72,800	£0 10 0	£169,200	0 0	
(Copper value not included.)					
Salt, ...	90,000	0 15 0	67,500	0 0	
Nitrate of soda, ...	2,500	14 15 0	36,875	0 0	
Chalk, ...	144,000	0 2 6	18,000	0 0	
Coals, ...	323,000	0 3 9	60,562	10 0	
Manganese, ...	11,400	4 0 0	45,600	0 0	
Rough Epsom salt, ...	1,500	2 5 0	3,375	0 0	
Magnesian limestone, ...	700	0 3 6	122	10 0	
French limestone, ...	14,000	0 4 6	3,150	0 0	
Resin, . . . . .	...	.....	.....		
Tallow, . . . . .	...	.....	.....		

FINISHED PRODUCTS.

Alkali, ...	43,500	£8 10 0	£369,750	0 0	
Crystals of soda, ...	51,300	4 15 0	243,675	0 0	
Bi-carbonate of soda, ...	7,450	12 0 0	89,400	0 0	
Caustic soda, ...	580	18 0 0	10,410	0 0	
Hyposulphite of soda, ...	400	25 0 0	10,000	0 0	
Oil of vitriol, ...	6,440	6 0 0	38,640	0 0	
Epsom salts, ...	1,500	7 5 0	10,870	0 0	
Hydrochloric acid, ...	180,000	.....	.....		
Sulphuric acid, used in the } manufacture of soda, ... }	86,320	.....	.....		
Bleaching powder, ...	11,200	9 0 0	100,800	0 0	
Soap, ...	6,000	34 0 0	204,000	0 0	
Yellow prussiate of potash, ...	105	0 1 0 ^{per} lb.	11,760	0 0	
Red ditto, ...	40	0 2 6 ^{per} lb.	11,200	0 0	
Alum, ...	4,000	7 0 0	28,000	0 0	
Carbonate of magnesia, ...	250	.....	7,500	0 0	
Superphosphate of lime, ...	15,000	5 0 0	75,000	0 0	
Pearl hardening, ...	2,000	10 0 0	20,000	0 0	
Sulphate of iron, ...	2,000	3 0 0	6,000	0 0	
Venetian red, ...	4,000	5 0 0	20,000	0 0	
Sulphate of copper, ...	100	35 0 0	3,500	0 0	
Resin size, ...	100	7 0 0	700	0 0	
Lamp black, ...	1,200	7 0 0	8,400	0 0	
Grease, ...	2,800	8 0 0	22,400	0 0	
Cements, ...	12,000	2 0 0	24,000	0 0	

“On Fractional Distillation.” By Professor WANKLYN.

"On the Constitution and Rational Formula of Narcotine." By Dr MATTHIESSEN, and G. C. FOSTER.

"Report on the Metallurgy of the District." By Mr I. L. BELL, Mr T. SOPWITH, Dr RICHARDSON, and Mr T. SPENCER.

"On the Separation of Lead and Antimony." By Dr RICHARDSON.

"On Titanium in Iron." By Dr RILEY.—Titanium appeared in small cubical crystals, and had long been observed in the hearts of blast furnaces, being always found in those that were used for making the best grey iron. Titanium ought no longer to be considered one of the rarer elements. It occurred very generally, and was a universal constituent of all clays. Stourbridge bricks contained 1·05 per cent. of titanium, and that estimation was much too low, because it was a difficult substance to determine. In mining shales he had found titanium—in some up to 3 or 4 per cent. The object of the paper, however, was to prove that under certain conditions it formed a constituent part of pig-iron, and appeared to have some beneficial effects in the manufacture of iron and steel. It acted somewhat similarly to manganese.

"On Thallium." By Mr I. L. BELL.

"On the Analysis of Chinese Iron." By Dr STEVENSON MACADAM.

"On Deposit in Blast Furnaces." By Mr J. PATTINSON.—The deposit was of a dark grey colour, and was impalpably fine powder. On analysis, it was found to contain as follows:—

Protoxide of iron, ...	14·22 per cent.
Oxide of zinc, ...	10·08 "
Sulphide of zinc, ...	13·70 "
Alumina, ...	8·20 "
Lime, ...	12·32 "
Magnesia, ...	5·03 "
Chloride of sodium, ...	4·74 "
Ammonia, ...	0·70 "
Thallium, ...	trace
Sulphuric acid, ...	3·18 "
Free sulphur, ...	0·17 "
Silica, ...	22·60 "
Carbonaceous matter, ...	4·50 "
	99·84 "

"On Zinc, Nickel, and Cobalt in Cleveland Ironstone." By Mr J. PATTINSON.—The author has estimated the amounts of nickel and cobalt contained in pig-iron, malleable iron, and puddling furnace cinder, all of which were produced from Cleveland ironstone, without any admixture of other ores. The samples were kindly supplied by Messrs. Bolckow and Vaughan, of Middlesbro'. In each case, four ounces of the sample were operated upon. They contained as follows:—

	Pig Iron.	Malleable Iron.	Puddling Furnace Cinder.
Grains of nickel per lb, ...	1·88	1·56	0·313
Grains of cobalt per lb., ...	0·32	0·24	0·062
Per-centage of nickel, ...	0·027	0·022	0·0045
Per-centage of cobalt, ...	0·004	8·003	0·0009

"On the Manufacture of Aluminium." By Mr ISAAC L. CELL.—The author gave an account of the usual mode of manufacture of aluminium, and pointed out the presence of impurities which materially interfered

with the manufacture of aluminium-bronze. These considerations have led manufacturers both here and in France to adopt the use of another raw material for the production of aluminium, which either does not contain the impurities referred to as so prejudicial, or contains them in such a form as to admit of their easy separation. This material is Bauxite, so called from the name of the locality where it is found in France. It contains—

Silica, ...	2·8
Titanium, ...	3·1
Sesqui-oxide of iron	25·3
Alumina, ...	57·4
Carbonate of lime, ...	0·4
Water, ...	10·8

The Bauxite is ground and mixed with the ordinary alkali of commerce, heated in a furnace. The metal is so extensively used in the arts as to keep the only work in England, namely, that at Washington, pretty actively employed. As a substance for works of art, when whitened by means of hydrofluorine and phosphoric acid, it appears well adapted, as it runs into the most complicated patterns, and has the advantage of preserving its colour from the absence of all tendency to unite with sulphur, or become affected by sulphuretted hydrogen. A large amount of the increased activity in the manufacture referred to is due to the exceeding beauty of its compound with copper, which is so like gold as scarcely to be distinguishable from that metal, with the additional valuable property of being nearly as hard as iron.

“Report on the Chemical Nature of Alloys.” By Dr MATTHIESEN.

“On the Extraction of Thallium from the Flue Dust of Pyrites Burners.” By W. CROOKS, F.R.S.

“On the Impurities contained in Lead, and their Influence on its Technical Uses.” By W. BAKER, F.C.S.

“On the Slaking of Quick-Lime.” By Dr JOHN DAVY.

“On Molecular Motion.” By Dr ZENNER.

“On the Analysis of Chinese Iron.” By Dr STEVENSON MACADAM.

“Définir par la végétation l'état moléculaire des corps. Analyser la force végétale par des essais raisonnés de culture.” By M. GEO. VILLE.

“Report on Synthetic Researches on the Formation of Minerals.” By Mr ALPHONSE GAGES.

“On a New Method of Measuring the Chemical Action of the Sun's Rays.” By Dr F. L. PHIPSON.—The writer happened to notice, lately, that a solution of sulphate of molybdic acid (that is, a solution of molybdic acid, or molybdic ammonia, in excess of sulphuric acid) standing in his laboratory upon a shelf which is partly exposed to the sun for about three hours each day, became bluish-green in the daytime and colourless at night. He repeated the experiment several times, and found that the saline solution when exposed to the sun was reduced, but when withdrawn from its influence, it gradually became colourless again by oxidation. No evolution of gas, however, was observed. During the insolation a certain amount of the molybdic acid loses one equivalent of oxygen, which combines with the water and forms oxygenated water, and during the night, the latter gives back its oxygen to the molybdic acid produced; the whole being in presence of an excess of sulphuric acid. Nothing is easier than

to measure with the greatest accuracy the amount of reduction which takes place by the action in a given time.

"On Musical Sounds produced by Carbon." By Dr F. L. PHIPSON.—The author has found that a fragment of homogenous wood charcoal, about a foot long and an inch thick, suspended by a string, and struck with a hammer, emits a beautiful musical sound, resembling that given out by glass and aluminium.

"On New Zealand Lignites." By Dr MURRAY THOMSON.

"On the Chemical and Physical Principles in Connection with the Specific Gravity of Liquid and Solid Substances." By Dr OTTO RICHTER.

Mr W. SYMONS exhibited a new form of Gas Battery.

"On Oxidation by Ozone." By Dr T. WOOD.

"On the Manufacture of Superphosphates, and Dissolved Bones." By Dr S. MACADAM.

"Recent Applications of the Hydrocarbons derived from Artificial and Natural Sources." By Dr B. H. PAUL.

"On the Uses of Fuel in Marine Boilers." By Dr RICHARDSON and Mr T. W. BUNNING.—It being understood that mixtures of Hartley and Welsh coal were being burnt on board the Imperial navy in France, some experiments were recently tried in the Government Yard in this country upon those mixtures. Dr Richardson and Mr Theo. W. Bunning were deputed to be present on the occasion. In order to register the amount of the smoke, which had hitherto been considered the chief disadvantage in the use of the Hartley coal, they adopted a series of figures to represent the different intensities of the smoke. Under this arrangement, it was found that while the "Hartley" made 340 marks of smoke and the "Welsh" 40, an equal mixture of the Hartley and the Welsh made only one mark. That was, there was only smoke of the lightest description issuing from the chimney for one minute, during the whole of the experiments, which lasted six hours. The coal was burnt in an ordinary boiler, used for making experiments on the different cargoes of coals applied to the yard; the coals were stoked by an ordinary Government stoker without any precautions, and the doors were of the usual closed description employed in Her Majesty's Navy. The result of this application would be to furnish a remedy for the great nuisance of smoke which existed in all ocean-going steamers, and a great saving would at the same time be effected.

"On Impurities in Lead." By Dr ZENNER.

"Sur les procédés de gravure du verre à l'aide de l'acide fluorhydrique par impression de la réserve." By M. L. KESSLER.

"Sur des appareils nouveaux évaporant à multiple effet et à air libre nommés *Évaporateurs*." By M. L. KESSLER.

"Sur les avantages commerciaux d'un nouveau sel de soude cristallisé." By M. L. KESSLER.

"On Photoelectric Engraving, and Observations upon Sundry Processes of Photographic Engraving." By Mr DUNCAN C. DALLAS.

"Are Nitrogen and Carbonic Oxide the Oxide of Carbon in different Allotropic or Isomeric states?" By Mr H. KILGOUR.

"Report on Synthetic Researches on the Formation of Minerals." By Mr ALPHONSE GAGES.

"On the Minerals and Salts found in Coal Pits." By Messrs R. C. CLAPHAM and J. DAGLISH.

“Researches on the Manufacture of Prussiate of Potash by the late John Lee and T. Richardson.” By Dr RICHARDSON.

“On the Constant Increase of Organic Matter in Cultivated Soils.” By Dr F. L. PHIPSON.

SECTION C.—GEOLOGY.

President—Professor WARRINGTON W. SMYTH.

“On Coal, Coke, and Coal Mining in Northumberland and Durham.” By Messrs N. WOOD, J. TAYLOR, J. MARLEY, and J. W. PEASE.

“On the Fossil Teeth of a Horse found in the Red Clay at Stockton.” By J. HOGG, M.A.

“On the Coal Measures of Sydney, Cape Breton.” By Mr J. P. LESLEY.

“On the Magnesian Limestone of the County of Durham.” By Messrs G. B. FORSTER and J. DAGLISH.

“On the Skiddaw Slate Fossils.” By Professor HARKNESS.

“On the Hornblendic Greenstones and their relations to the Metamorphic and Silurian Rocks of the County of Tyrone.” By Professor HARKNESS.

“On Two New Coal-Plants from Nova Scotia.” By Dr DAWSON.—One of the plants, *L. Acadianus*, belonged to the genus *Lepidophloios* of Sternberg; the other was an example of a type of *Lepidodendron*, very characteristic in Nova Scotia of the lower coal measures associated with the lower carboniferous limestone. The author concluded that the original species of Sternberg, *L. caricinum*, was founded on the fragment of the bark of an old trunk, having the leaf bases flattened, and hence described as scales. It was evidently, in short, closely allied to the specimen described. The genus *Ulodendron* was, he thought, identical with *Lepidophloios*, but apparently founded on specimens having the leaf bases preserved, with the cone scars, but wanting vascular scars; but he was in doubt as to the claims of the name *Ulodendron* on the ground of priority. It appeared to him that the generic names *Ulodendron*, *Lomatophloios*, *Leptoxylum*, *Pachyphloeus*, and *Bothrodendron* should be abolished in favour of *Lepidophloios*, unless indeed it should appear that any of these names had priority in date. The second plant described was the *Lepidodendron corrugatum*, which was one of the most abundant in the lower coal measures of Nova Scotia and New Brunswick. The species was remarkable for its variability, and also for the dissimilar appearances of old stems and branches occasioned by the separation of the areoles in the growth of the bark, instead of the areoles themselves increasing in size, as in some other *Lepidodendra*.

“On Models illustrating the Contortions in Mica Schist and Slate.” By Mr H. C. SORBY.

“On a Deposit of Sulphur in Corfu.” By Professor ANSTED.

“On the Metamorphic Origin of the Porphyritic Rocks of Charnwood Forest.” By Professor ANSTED.—The part of England referred to is a small district in the county of Leicester, east of the various other developments of igneous rock in England. The object of this paper was to show that the rocks, consisting of syenites, granites, and others of the appearance and character generally regarded as igneous, were really of the same date as the slates with which they seem to alternate.

“On the Laurentian Rocks in the Malvern Hills.” By Mr E. HOLL.

“On the Equivalents of the Cleveland Hill Ironstones in the West of England.” By Mr C. MOORE.

“On the Organic Contents of the Lead Veins of Allenheads and of Yorkshire.” By Mr C. MOORE.

“Report on the Distribution of the Organic Remains of the North Staffordshire Coal-field.”—Read by Mr MULLINS.

“On the Chronological Value of the Triassic Rocks of Devonshire.” By Mr WILLIAM PENGELLY.—The red rocks of Devonshire are eminently detrital, and consist of conglomerates, sandstones, and marls, and belong to the Bunter or Lower Trias. They occupy the whole of the country east of a line from Torbay to Porlock in West Somerset. The general dip is about $15\frac{1}{2}$ degrees in the direction N. and $44\frac{1}{2}$ degrees E. (true), so that, judging from this horizontal extension in this direction, their volume must be enormous. The conglomerates and sandstone, in every layer, afford evidence of their littoral origin, and of their having been deposited on a tidal strand undergoing slow subsidence.

“On the Causes of Earthquakes and Volcanic Eruptions.” By Mr J. ALEXANDER DAVIES.

“On the Physical Condition of the Earth in the Earlier Epochs of its History.” By the Rev. JAMES BRODIE.

“On a Help to the Identification of Fossil Bivalve Shells.” By Mr HARRY SEELEY.

“On the Penine Fault.” By Mr W. BAINBRIDGE.

“On Coal in the Red Measures.” By MATTHIAS DUNN, Government Mine Inspector.—After noticing generally the Cumberland Coal-fields and the New Red Sandstone, Mr Dunn said—I have been led to form the idea that the Red Sandstone is but the superior strata of the coal field, and that the neighbouring coal seams will be *found underneath*; and judging from the flatness of the country around Silloth Harbour, I have assumed that the bottom of the basin will exist in that quarter, for appearances of a coal outcrop exist in the neighbourhood of the Criffle mountains in Kirkcudbright. In pursuance of this theory, I assume that the coal-field of Canobie is similarly circumstanced, for the Red Sandstone there crops out contiguous to the pits, and the nature of the various seams of coal assimilate closely upon those of Cumberland. Another corresponding fact attends the colliery of Kirkhouse belonging to the Earl of Carlisle, although a portion of it also contains coals belonging to the Limestone formation.

“On the Recent Discovery of Gold near Bala Lake (Llyn Tegd), Merionethshire.” By T. A. READWIN, F.G.S.

“On the Origin of Granite.” By Mr ALEXANDER BRYSON.

“On the Deposit of the Gravel, Sand, and Loam, with Flint Implements at St Acheul.” By Professor PHILLIPS.—One of the remarkable fruits of geological investigation was to invest almost every point on the earth's surface with a new interest. The small French village named had long been remarkable for the school of the Jesuits established there; but antiquarians had discovered that it was near a burial ground of great antiquity. In the course of excavation there were discovered the graves of people far more ancient than any known to have been buried there. Other memorials were also discovered; and on one he had obtained from the workmen he read the name of Constantius. A stone coffin was found,

and also an armlet which had been placed on the arm of a buried person. When they looked in front of the great face of excavation and saw overhead the Jesuit College, the ancient Cemetery, and the Roman and Pre-Roman graves, the question arose, "What could be the antiquity of the sand and gravel-deposit at the lower level?" In Sir Charles Lyell's recently published volume the situation was fully described. Concerning the deposits, there was no difference of opinion; they were to be reckoned among the later deposits of the geological time, and in the lower parts of these deposits a great number of interesting implements had been obtained, and some of these he exhibited. He described the deposits in detail, from illustrations, stating that fresh-water and land shells were found in sand, and splintered flints in an argillaceous deposit over it. For the fresh-water and land shells in the gravel it was not necessary to appeal to the action of the sea, which, however, was seen in the lower part of the level. There were, in different levels, cases of great agitation of water, comparative agitation, and comparative tranquillity. They might imagine a lacustrine deposit, against which there would be the objection that it would not produce gravel in such a form, it being twisted about in all ways. There ought to have been found lying parallel to the surface of the lake a great number of lacustrine shells; but that was not the case, and the explanation would not apply to the mixture of fresh-water and land and amphibious shells.* The more ordinary explanation was to suppose the action of a river which had changed its position, so that the flint instruments found near the bottom might formerly have existed near the top. The arrangement of the sands was obviously of such a kind that they floated over the pebbles and covered all below. The whole question came finally to this:—Could they determine the age of the gravel beds? They could not escape the conviction that the flint instruments were of the same age as the gravel beds. Upon the supposition of strata having been deposited by river action, the upper surface of the deposits would continually tend to become level, and would be so when the deposits were of an argillaceous nature. In this case the slope varied from $2\frac{1}{2}$ to $1\frac{1}{2}$ degrees. In order to account for the present condition of things, it would be necessary to suppose that the country had been disturbed, and that there had been an elevation affecting the valley of Somme. On an examination of the locality, they would speedily arrive at the impression that it was requisite to remember that there was no period of geological history from which it was safe to exclude a movement of the earth's crust. The map of France showed the causes of the elevation. The rivers ran in parallel lines across the chalk, and it was impossible to separate the circumstance from the similar fact in this country where these phenomena had been discovered. As there was reason to think that the valley had been subject to upheaval, accepting the supposition, they would not be able to determine the question of age by the excavation of the river. If they followed the suggestion of Sir C. Lyell, and took their measure from Scandinavia, they might come to some determination as to time; but this was a case of a local disturbance of the earth's crust, affecting certain lines of country in a given direction, and apparently ceasing beyond that. As it would be to some purpose to ascertain the antiquity of these deposits, he trusted Sir C. Lyell would not think it otherwise than a compliment to hear an opinion differing from his own.

"On the Drift Beds at Mundesley, Norfolk." By Professor PHILLIPS. —Professor Phillips made a statement respecting the drift beds at Mundesley, Norfolk, remarking that he did so to confirm some views which

were of the greatest importance in reasoning with regard to the antiquity of mankind, and at the same time of suggesting a mode of consideration which he hoped could be followed up. The district on the coast of Norfolk, where the cliffs belong to the glacial, postglacial, and preglacial periods, had become famous owing to the investigations of Mr Taylor a few years ago. Some thirty years ago in Yorkshire, below the boulder clay, there was found a quantity of flint and chalk gravel which contained the bones of elephants, horses, and other creatures. Soon afterwards he became acquainted with this similar discovery in Norfolk. Having described these deposits, the Professor said he was inclined to think they must not venture to apply to this country any argument drawn from Scandinavia. They must have each country studied for itself, and then they might possibly arrive at a satisfactory conclusion. It was far better to take each class of glacial deposits by itself. He thought it possible to account for these deposits by the introduction of the tide at different levels, and that it was not at all necessary to suppose that the coast had been disturbed in order to account for the level of the marine shells. He was inclined to think that all those strata were to be put together as the deposit of one period; and he thought Norwich Crag was too local a name to apply to so remarkable a set of deposits.

“On the Alluvial Accumulations in the Valleys of the Somme and Ouse.” By MR R. A. GODWIN-AUSTEN.

Sir C. LYELL said he had expected to hear Professor Phillips and Mr Godwin-Austen express a wider divergence from his own conclusions than they had done. He took it for granted that Professor Phillips agreed with him in the important point, that not only the flint implements which he mentioned in the case of St Acheul were of the same age as the old river gravel, but also the extinct mammalia. It therefore appeared that they agreed in the important point of the co-existence of man with those extinct animals. The new view which he had attempted to explain was, that the upper valley gravel, some 80 or 100 feet above the level of the sea, was not now in the position it was when the river flowed there and formed this extensive deposit of sand and gravel. If he understood the argument, there was such a slope of the gravel covered with loam towards the Somme as there would not be if it was the deposit of a considerable river in its original state; in that case the slope would be the other way, from the river towards the bluffs, as in the case of the Rhine and the Mississippi. He was not prepared to say whether it was possible to calculate on the identity of the present state of that surface with what it was at the very remote period when it was formed, and since which it must have had so many washes by rain during many thousand years. He was not prepared to say whether they could reason in that manner as to a change of position. What he said was, that there was nothing in his speculations on the river gravels hostile to the conclusions which Professor Phillips had proposed, of there having been possible local movements, or, at any rate, a considerable movement of that country since the old river flowed. He thought it was almost impossible that that should not be the case. Indeed, when he found two levels of river gravel, one higher and the other lower, it generally appeared to him that that must be in consequence of some great movement, that there must have been probably some stationary period, when great accumulations took place, and that there must have been a period of movement, the waters eroding and cutting away the country, until they settled down at a lower level, and there was a formation of gravel there. This was a most probable thing; but they must bear in mind that though they talked of these

appearances at two different levels, there were occasionally intermediate levels and deposits of gravel even higher than St Acheul. It would be difficult to suppose that it was always strictly at two levels that these gravel beds occurred; but there was a prevalence of them at a higher level and at a lower level, that lower level being necessarily higher than that of the present Somme. He therefore had no objection to suppose that, after the country had been for some time in that state at which the gravels and sand were formed, there was some movement or elevation during which the river was able to cut the land down, and then form the inferior or lower level gravels; and it did not appear to him that if that view were adopted it made any very essential difference. Professor Phillips thought it made this difference—that the time would be much shorter if there were such a movement, and certainly it would; but he could hardly conceive any movement would enable the river to destroy so much older strata, as it must have destroyed to produce such reiterated river beds. If Professor Phillips could bring evidence of such a movement it would be a great assistance; but that would not alter at all any views at which Mr Prestwich and himself had arrived with regard to the manner in which the higher and the lower levels were formed. There were other proofs besides the fresh-water shells and the absence of marine animals of the fluviatile origin of the St Acheul gravels. The gravel in the Somme, the Seine, and their tributaries was composed of rock that belonged to the hydrographical beds of those rivers. In addition there was the presence of fluviatile shells as well as of land animals. He could receive the views of Mr Prestwich that these gravels were remains of an old river; and he could admit that there might have been such a movement as Professor Phillips had supposed. Mr Austen, in speaking of the Bedford section, had endeavoured to do away with the argument in favour of the antiquity of man by supposing that the remains of extinct lions, rhinoceroses, and other animals, taken out of the gravel, which was about thirty feet above the level of the sea, were derived from an older gravel. He supposed some pre-existing formation, out of which the bones were taken, and then deposited in the present, so that that formation which contained the flint instruments would not be proof of the co-existence of man with those extinct mammalia, and that the mammalia existed before and were washed out into the beds containing the flint instruments. Such an objection might be made to almost every river bed, because rivers were constantly ploughing up their channels—doing and undoing. Therefore, if any animal remains had sunk in the channel, the chances were that they would be torn out again and rolled on before they got to their final resting-place. It was perfectly true that in some of our valleys, such as the Severn, the old drift containing distinct animals will be undermined, and occasionally bones in a state of integrity will be thrown down into the new river bed. There were such cases, and they were guarded with respect to them; but as a general rule, if they found remains buried in gravel, the inference was that they were formed during that long period when that ancient growth was deposited, bed after bed, and sometimes partly destroyed and re-deposited. If a geologist wished to draw a contrary conclusion, he was bound to show, first of all where was the old formation out of which these extinct bones were derived. To make out his theory, he would be bound to show that such a formation was under the drift of that country; which, however, was not the case. Under the circumstances, the hypothesis seemed a violent one, formed to get rid of a violent conclusion, to suppose that these bones had been derived from some other formation that existed in the neighbourhood, without a shadow of evidence of there having been such a one, and with all the existing evidence against it. He hoped the

conclusion was one which, on reconsideration, Mr Austen would not continue to maintain.

"On certain Markings on the Horns of *Megaceros Hibernicus*." By Mr J. B. JUKES.

"On the Discovery of Elephant and other Mammalian Remains in Oxfordshire." By Mr G. E. ROBERTS.—Part of the bones have been submitted to Dr Falconer, who has recognised *Elephas primigenius* of the Siberian tribe, teeth and other remains rather abundant; *Elephas antiquus*; a large species of *Bos*—(*primigenius*? or *priscus*?) top of radius, tibia, and horn core; many bones and teeth of *Equus caballus fossilis*, including a finely preserved tibia of great size, and a portion of another still larger; and some good fragmentary specimens of the horns of *Cervus elephas*.

"Some Facts relating to the Hydrography of the St Lawrence, and the Great Lakes." By Dr HURLBURT.

"Report on the Chemical and the Mineralogical Composition of the Granite of Donegal." By a Committee, consisting of Mr SCOTT, Sir R. GRIFFITH, and Professor HOUGHTON.

"On the Origin of the Jointed Prismatic Structure in Basalts and other Igneous Rocks." By Professor JAMES THOMSON.

"On a Synopsis of the Bivalved Entomostraca of the Carboniferous Strata of Great Britain and Ireland." By Professor T. RUPERT JONES and Mr J. W. KIRKBY.

"Notes on some Fossil and recent Foraminifera, collected in Jamaica, by the late Lucas Barrett, F.G.S." By Professor T. RUPERT JONES and Mr W. K. PARKER.

"On some Fossil Fishes from the Permian Limestone of Fulwell, near Sunderland." By Mr J. W. KIRKBY.

"Report of the Shetland Dredging Committee, in its Geological bearings." By Mr J. GWYN JEFFREYS.

"A List of the Upper Tertiary Fossils of Uddewalla in Sweden." By Mr J. GWYN JEFFREYS.

"On the Upper Tertiary Strata of the Bohuslän District." By Dr A. W. MALM.

"On a Wash or Drift through the Coal-Field of Durham." By Mr NICHOLAS WOOD and Mr EDWARD F. BOYD.

"Observations on the Permians of the N.W. of England." By Sir RODERICK I. MURCHISON and Professor HARKNESS.

"On a Salamander in the Rothengendes." By Dr GEINITZ.

"On the Reptiliferous and Footprint Sandstones of the N.E. of Scotland." By Professor HARKNESS.

"On some Remains of *Bothriolepis* from the Upper Old Red Sandstone of Elgin." By Mr G. E. ROBERTS.

"On the Occurrence of Rock Salt at Middlesbro." By Mr JOHN MARLEY.—He stated that a bed of salt, 100 feet thick, had been already bored.

"Description of a Sea Star (*Cribellites carbonarius*) from the Mountain Limestone of Northumberland, with a Notice of its association with Carboniferous Plants." By Mr GEORGE TATE.—Previously no species of *Asteroides* had been recorded from this formation. The specimen exhibited, found by Mr W. Wilson of Shilbottle, was an impression of the

upper surface only of the organism, in a yellow, fine-grained micaceous sandstone, and, although imperfect, yet being doubtless a sea star, and the first discovered in the formation, it deserved the attention of palæontologists. The following characters could be observed:—Rays five, rounded, lanceolate, five times as long as the disk, ridged in the centre, covered with longitudinal rows of reticulating tubercles; disk small and tuberculated. The disk was only $\cdot 3$ of an inch in diameter, whilst the rays were 1·5 inch in length. The sandstone from which this asteroid was obtained was about twenty feet above the Shilbottle coal, and about ten feet below the “18-foot limestone,” which was the fifth limestone sill in the mountain limestone of Northumberland; it was, he estimated, about 600 feet below the base of the mill-stone grit; and as the formation was about 3000 feet in thickness, it was in the upper part of this series of beds.

“Some Facts observed in Weardale.” By Mr CHARLES ATTWOOD.

“On a Section of the Strata from Hownesgill to Cross Fell.” By Mr T. SOPWITH.

“On the Neanderthal Skull, or Reasons for believing it to belong to the Clydian Period, and to be specifically distinct from Man.” By Professor WILLIAM KING.

“On some Fish Remains that have occurred in the Coal Measures of Durham and Northumberland.” By Mr THOS. ATHEY and Mr JAMES W. KIRKBY.

SECTION D.—ZOOLOGY AND BOTANY.

President—Professor BALFOUR.

Mr J. G. JEFFREYS read the “Report of the Committee appointed for Exploring the Coast of Shetland by Means of the Dredge.”—After explaining the nature of such researches, as well as their utility in a zoological and geological point of view, the author gave a short history of the marine invertebrata of the Shetland seas during the last half-century. He described the result of the expeditions which he had undertaken to this remote district since 1841. Several zoological problems of real interest were then discussed; viz. the colour of animals living at great depths,—the condition and composition of the sea-bed,—the idea that certain species were now “dying out,” which the author opposed,—the distribution of certain species,—the absence of the Gulf Stream on the eastern and northern coasts of Shetland,—the gradual sinking of the sea-bed since the glacial epoch,—the lively state of mollusca taken from the deep, and kept in a shallow vessel filled with sea-water from the beach,—and also the improbability of any marine strata being unfossiliferous except when they have been subjected to chemical action.

“On the Cultivation of Cinchona in India.” By Mr C. R. MARKHAM.

“On the Zoology of Hylton Dene, near Sunderland.” By Mr G. S. BRADY.

“On the Marine Cyclopoid Entomostraca (Calanidæ), with Notices of some Species new to Britain.” By Mr G. S. BRADY.

“Descriptions of New British Polyzoa, with Remarks on some imperfectly known Species.” By Mr J. ALDER.—The species forming the subject of this communication belong chiefly to the branched calcareous forms of the genera *Cellepora* and *Eschara*. The new species described were named *Cellepora lavigata*, *Eschara ligulata*, and *Palmicellaria*

elegans, the latter also a new genus, proposed for a beautiful little coral, dredged this year in Shetland by the Rev. A. M. NORMAN. The species remarked upon included the *Eschara levis* of Fleming, a species lost sight of by British naturalists for many years; *Eschara Landsborovii*, now first ascertained to be an *Eschara*, but the imperfect state of which had been described by Dr Johnston as a *Lepralia*: this was found on the coast of Northumberland by Mr Embleton; *Quadricellaria gracilis* of Sars, previously described from an imperfect specimen under the name of *Onchopora borealis*, by Professor Busk; *Scrupocelaria Delilii*, a species new to Britain, got on the Northumberland coast; and *Hornera borealis*, Busk, now introduced as British for the first time.

"On the Colour of the Salmon." By Dr DAVY.—This paper appears in the present Number of this Journal.

"On the Structure of the Fruit of *Clerodendron Thomsonæ* (Balf)." By the PRESIDENT.

"On some Elucidations of the Geological History of North Africa, supplied by its Lacustrine Fauna." By the Rev. H. B. TRISTRAM.

The Rev. A. M. NORMAN read the second part of the "Report of the Committee appointed to Dredge the Shetland Seas."—The first part of the Report, which was read on the previous day, had reference solely to Mollusca, while the second treated of Crustaceans and their Parasites. Mr Norman added a description of a great number of caves in a firth called Burrough Firth, to the extreme north of Shetland. These caves, which are the most beautiful in the British islands, possess the greatest interest to the naturalist. They are situated in rocks, shelving at an angle to the south-west, and marked by regular strata of various colours, and the interior of the caves is rendered brilliant by millions of zoophytes of every colour.

Captain WOODALL gave Reports of the Results of a 'Three Weeks' Dredging Cruise off Scarborough in 1863, by Mr Leckenby, which was undertaken upon the promises afforded by an examination last year, that it might be possible to define more satisfactorily than had yet been done, the area, extent and description of the invertebrates on the north-east coast of England. The examinations were made within ten miles of the shore, in from twenty to twenty-five fathoms, and near Flamborough Head, and the cost of the expedition was only about L.30. Cannon-balls were carried to weight the dredger in case the weather freshened, and the author recommended that the same precaution should be adopted in other similar expeditions.

"An Account of the Attempts to Transport Salmon to Australia." By Mr T. JOHNSON.—It was shown that ova might be kept in ice for ninety or more days, and afterwards produce young salmon.

"On the Roman and Imperial Crested Eagles." By Mr J. HOGG.

"On a New Species of Ione." By Mr C. S. BATE.

"Note on certain Influences regulating the Forms of Leaves," &c. By Dr M. T. MASTERS.

"Notes on Canadian Forests." By Dr HURLBURT.

"On the Syndactylous Condition of the Hand in Man and the Anthropoid Apes." By Mr C. CARTER BLAKE.

"Notes on the Occurrence of Foraminifera new to the British Seas." By Mr H. B. BRADY.—After some preliminary remarks on the various methods of separating recent *foraminifera* from bulky material, the

author proceeded to read notes upon the following forms not hitherto recorded as British, which had, with one exception, resulted from the examination of sands dredged by Mr Gwyn Jeffreys and Mr Waller round the Shetland Islands—the exceptional case, *Pulvinulina Menardii*, D'O., having been found in soundings from the Irish Sea:—

Biloculina sphaera, D'O.; *Biloculina contraria*, D'O.; *Triloculina tricarinata*, D'O.; *Quinqueloculina pulchella*, D'O.; *Lituola scorpiurus*, Montfort; *Lagena distoma*, P. and J.; *Glandulina laevigata*, D'O.; *Bigenerina digitata*, D'O.; *Bolivina punctata*, D'O.; *Planorbulina Haidingerii*, D'O.; *Planorbulina Ungeriana*, D'O.; *Pulvinulina concentrica*, P. and J.; *Pulvinulina Karsteni*, R.; *Rotalia orbicularis*, D'O.; *Discorbina Berchelotiana*, D'O.; *Anomalina coronata*, P. and J.; *Polystomella crispa* var. *arctica*, P. and J.; *Nonionina stellifera*, D'O.; and *Pulvinulina Menardii*, D'O.

“Notes on some recent Foraminifera, dredged at Jamaica by the late Lucas Barrett, F.G.S.” By Professor T. RUPERT JONES and Mr W. K. PARKER.

“Notes on the Homologies of the Trilobites.” By Mr. C. SPENCE BATE.

“On the Geographical Distribution of Animal Life.” By Mr A. R. WALLACE.—The author called attention to the six geographical regions established by Dr Sclater (Proc. Lin. S., Feb. 1856) for ornithology,—viz., 1st, The Neotropical, comprising South America and West Indies; 2d, The Nearctic, including the rest of North America; 3d, The Palæarctic, composed of Europe, Northern Asia to Japan and Africa, north of the Desert; 4th, The Ethiopical, which contains the rest of Africa and Madagascar; 5th, The Indian, containing Southern Asia and the western half of the Malay Archipelago; and 6th, The Australian, which comprised the eastern half of the Malay Islands, Australia, and most of the Pacific Islands. It was stated that these regions would apply almost equally well to mammalia, reptiles, land shells, and insects,—excepting some exceptional cases, which it was thought would render these regions inapplicable to zoology generally. These exceptional cases were—1st, That the Batrachians of Japan were Palæarctic, agreeing with the birds, &c., but the snakes were altogether Indian, as pointed out by Dr Gunther in his paper on the geographical distribution of reptiles (Proc. Zool. Soc. 1858, p. 373); 2d, That the mammalia of North Africa were not European like the birds; 3d, That the insects of the Moluccas and New Guinea were generally of Indian forms, while the birds and mammals were Australian; and 4th, That the insects of Chili were of North Temperate and Australian forms, while the birds and mammals were mostly of true South American groups. These cases were treated successively; and it was shown that the statement as to the mammals of North Africa was incorrect, and that they really very strongly confirmed the evidence of the birds and reptiles as to that country being Palæarctic. In the other cases, the anomalies of distribution were explained as being due to special exceptional circumstances, which should not invalidate the general accuracy and usefulness of these divisions. The discrepancies in the distribution of plants, which, while often agreeing with those of insects, were much greater, were supposed to be in a great measure due to the adventitious action of the glacial epoch and of floating ice.

“A Few Facts on the Variation of Species pointing to Western Asia as the Centre of the Palæarctic Area of Creation.” By the Rev. H. B. TRISTRAM.—No one would suppose that the creation or development of

animals had gone on simultaneously all over one region, so as to exclude the idea of animals or insects first appearing in some particular centre under certain circumstances, and thence gradually extending themselves wherever the situation was best adapted to their habitation. His idea was, that they could trace through the whole of the Palæarctic region, from Iceland to Japan, some predominant forms, varying in greater or less degrees, and that whilst the variations were generally longitudinal, the identical forms were preserved latitudinally. Amongst the instances he quoted were the grey wagtail, the yellow wagtail, the green woodpecker, and the azure-winged magpie. The universality of some species did not, he thought, tell much against his theory, because those which did occur universally, or almost universally, as the snipe and osprey, had such powers of locomotion that they could from one centre disperse themselves in all directions. In regard to land shells, the same rule appeared to apply. Of course, in shells it was very difficult to ascertain the whole of the species to be discovered in the Caucasian and North Persian district, because it had not been much worked; but taking the western region, there was not a single shell in Ireland which was not to be found in England, and not one in England that was not, with some few exceptions, to be found in Germany; but the number of species in England more than doubled the number in Ireland, and the number in Germany more than doubled the number in England. Thus they found the species largely increasing as they went towards the East, wherever there was sufficient lime for the creatures to form their shell; and while very few of our English species were lost, new ones were continually found. What he wished to submit was, that the variation of species, taking the instances of some of our most familiar birds, the general geography of zoology pointed out, that in the Palæarctic region, Central Asia was the centre from which they had passed eastward and westward.

“Description of a New Plant-house.” By Mr JAMES BEWLEY.

“A Brief Account of the Vegetation of the Cliffs of Mohir, County Clare.” By Mr N. B. WARD.

“On the Occurrence of the Sperm Whale (*Physeter macrocephalus*) at Wick.” By Mr CHARLES W. PEACH.

“Notice of a Monstrosity in a Whiting.” By Mr C. W. ROSE.—The whiting had three eyes, two in their natural position and one between the two.

“On the Physical Geography of the Malay Archipelago.” By Mr A. R. WALLACE.—It first becomes necessary to define accurately the limits of the Archipelago, pointing out exactly what islands we include within it; for, though “all the islands between south-eastern Asia and Australia” seem pretty definite, yet to the eastward this region blends insensibly into the vast extent of the Pacific Islands. According to my views, the Malay—or, as I should prefer to name it, the Indo-Australian—Archipelago extends from the Nicobar Islands on the north-west to St Christoval, one of the Solomon Islands, on the south-east, and from Luzon on the north to Rotti, near Timor, on the south. The eastern boundary is drawn at this particular point for reasons which will be explained further on. Though not geographically correct to include any part of a continent in an archipelago, it is necessary for our purpose to consider the Malay peninsula as not only almost but quite an island, since it cannot be physically separated from the region of which we are now treating. Thus limited, the Archipelago is of a somewhat triangular form, with an extreme length of about 5000, and breadth of rather more than 2000

English miles. Looking at a map on which the volcanic regions of the Archipelago are marked out—those which are subject to earthquakes which are of volcanic origin, and which abound more or less in extinct as well as active volcanoes,—we see at a glance that the great islands of Borneo and Celebes form the central mass around which the volcanic islands are distributed, so as rudely to follow their outline and embrace them on every side but one in a vast fiery girdle. Along this great volcanic band (about 5000 miles in length) at least fifty mountains are continually active, visibly emitting smoke or vapour; a much larger number are known to have been in eruption during the last 300 years; while the number which are so decidedly of volcanic origin that they may at any moment burst forth again, must be reckoned by hundreds. It is not now my object to describe the many fearful eruptions that have taken place in this region. In the amount of injury to life and property, and in the magnitude of their effects, they have not been surpassed by any upon record. Forty villages were destroyed by the eruption of Papandayang in Java, where the whole mountain was blown up by repeated explosions, and a large lake left in its place. By the great eruption of Tomboro in Sumbawa, 12,000 people were destroyed, and the ashes darkened the air, and fell thick upon the earth and sea for 300 miles round. Even quite recently, since I quitted the country, a mountain which has been quiescent for more than 200 years suddenly burst into activity. The island of Makian, one of the Moluccas, was rent open in 1646 by a violent eruption which left a huge chasm on one side, extending into the heart of the mountain. It was, when I last visited it, clothed with vegetation to the summit, and contained twelve populous Malay villages. On the 29th of December 1862, after 215 years of perfect inaction, it again suddenly burst forth, blowing up and completely altering the appearance of the mountain, destroying the greater part of the inhabitants, and sending forth such volumes of ashes as to darken the air at Ternate, 40 miles off, and almost entirely to destroy the growing crops on that and the surrounding islands. The island of Java contains more volcanoes, active and extinct, than any other known district of equal extent. They are about forty-five in number, and many of them exhibit most beautiful examples of the volcanic cone on a large scale, single or double, with entire or truncated summits, and averaging 10,000 feet high. It is now well ascertained that almost all volcanoes have been slowly built up by the accumulation of the matter—mud, ashes, and lava—ejected by themselves. The openings or craters, however, frequently shift their position; so that a country may be covered with a more or less irregular series of hills in chains and masses, only here and there rising into lofty cones, and yet the whole may be produced by true volcanic action. In this manner the greater part of Java has been formed. The great island of Sumatra exhibits in proportion to its extent a much smaller number of volcanoes, and a considerable portion of it has had probably a non-volcanic origin. Going northward, Amboyna, a part of Bouru, and the west end of Ceram, the north part of Gilolo and all the small islands around it, the northern extremity of Celebes, and the islands of Siau and Sanguir are wholly volcanic. The Philippine Archipelago contains many active and extinct volcanoes. In striking contrast with this region of subterranean fires, the island of Celebes in all its southern peninsulas, the great mass of Borneo, and the Malay peninsula, are not known to contain a single volcano, active or extinct. To the east of the volcanic band is another quiescent area of 1000 miles wide, the great island of New Guinea being free from volcanoes and earthquakes. Towards its eastern extremity,

however, these re-appear in some small islands off its coast, and in New Britain, New Ireland, and the Solomon Islands, which contain active volcanoes. The contrasts of vegetation and of climate in the Archipelago may be best considered together, the one being to some extent dependent on the other. Placed immediately upon the Equator, and surrounded by extensive oceans, it is not surprising that the various islands of the Archipelago should be almost always clothed with a forest vegetation from the level of the sea to the summits of the loftiest mountains. This is the general rule. Sumatra, New Guinea, Borneo, the Philippines, and the Moluccas, and the uncultivated parts of Java and Celebes, are all forest countries, except a few small and unimportant tracts, due perhaps, in some cases, to ancient cultivation or accidental fires. To this, however, there is one important exception in the island of Timor, and all the smaller islands opposite, in which there is absolutely no forest such as exists in the other islands, and this character extends in a lesser degree to Floris, Sumbawa, Lombock, and Bali. The changes of the monsoons and of the wet and dry seasons in some parts of the Archipelago are very puzzling; and an accurate series of observations in numerous localities is required to elucidate them. Speaking generally, the whole south-western part of the Archipelago, including the whole range of islands from Sumatra to Timor, with the larger half of Borneo and the southern peninsula of Celebes, have a dry season from April to November, with the south-east monsoon. This same wind, however, bends round Borneo, becoming the south-west monsoon in the China Sea, and bringing the rainy season to Northern Borneo and the Philippines. In the Moluccas and New Guinea the seasons are most uncertain. In the south-east monsoon from April to November, it is often stormy at sea, while on the islands it is very fine weather. There is generally not more than two or three months of dry hot weather about August and September. This is the case in the northern extremity of Celebes and in Bouru, whereas in Amboyna, July and August are the worst months in the year. In Ternate, where I resided at intervals for three years, I never could find out which was the wet and which the dry season. The same is the case at Banda, and a similar uncertainty prevails in Menado, showing probably that the proximity of active volcanoes has a great disturbing meteorological influence. In New Guinea a great amount of rain falls more or less all the year round. On the whole, the only general statement we can make seems to be, that the countries within about 3° on each side of the Equator have much rain and not very strongly contrasted seasons; while those with more south or north latitude have daily rains during about four months in the year, while for five or six months there is almost always a cloudless sky and a continual drought. He next considered the Malayan Archipelago in its geological and zoological relations to Asia and to Australia, mentioning the well-established fact, that one portion of it is almost as much Asiatic in its organic productions as the British Isles are European, while the remainder bears the same relation to Australia that the West India Islands do to America.

“On the Irruption of *Syrnhaptes paradoxus*.” By Mr A. NEWTON.—These birds, which are commonly known as Pallas’ sand grouse, and which are of Chinese origin, have made recent visits to this country, but have been rapidly exterminated or driven away. It appeared that about 109 of these rare birds had been killed in the British Isles, of which 63 were shot in Norfolk and Suffolk.

“On the Generic Characters furnished by the different Modes of Mining
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Leaves adopted by the Larvæ of *Micro-Lepidoptera*." By Mr H. T. STANTON.

"On British Holothuriadæ with reference to New Species." By Rev. A. MERLE NORMAN.

"On the Morphology of the Echinodermata of the Family Ophiuridæ." By Rev. A. MERLE NORMAN.

"Report on the Natural History of the Island Formosa." By Mr ROBERT SWINHOE.

"Report on the Mollusca of California." By Mr P. P. CARPENTER.—This consisted of corrections of the first report, and a *resumé* of the fresh sources of information which had accumulated since its date. The most important results of recent investigation were the geological evidence of a recent connection between the waters of the West Indies and the Pacific, and also of the comparatively recent elevation of many parts of the Rocky Mountains, and the probable connection of the North Pacific and North Atlantic during the Eocene and probably the Miocene periods.

"On the Great Division of the Pacific Ocean Fauna." By Mr W. HARPER PEASE.—The connection of the Hawaiian Islands with the northern part of Japan by a series of sunken islands, identical in fauna with the Hawaiian, and the non-existence of certain islands appearing on the charts between that group and the coast of America, were dwelt upon with reference to the peculiarities of the existing fauna.

"On the Proliferous Cones of the Common Larch." By Mr JOHN HOGG.

"List of Rarer Phænogamous Plants in the South-east of Durham discovered since 1829." By Mr JOHN HOGG.

SUB-SECTION D.—PHYSIOLOGY.

President—Professor ROLLESTON.

"Notes on certain Parts of the Anatomy of a young Chimpanzee." By Dr EMBLETON.

"Observations on the Eggs of Birds." By Dr DAVY.

"On the Investigation of Instinctive Actions." Dr W. MURRAY.

"On the Ventilation of Barracks and other Public Buildings in India." By Mr S. CLARK.

"Report on the Physiological Effects of the Bromide of Ammonium." By Dr G. D. GIBB.—The general conclusions may be stated as follow:—1. In small doses more or less long continued, bromide of ammonium acts as a tonic and absorbent, and exerts its peculiar properties upon the skin and mucous membrane. 2. It diminishes the weight of the body in polysarcia, causing the absorption of fat, when combined with a regulated diet; and this is effected with greater certainty than by any other known substance. 3. It improves the intellectual powers, increases the bodily capacity, and promotes healthy function. 4. Locally, it possesses a soothing influence on the mucous membrane, and, according to the strength and mode of its application, so does it diminish sensibility. 5. In large frequently repeated doses, or given at intervals, it influences the entire mucous tract; it affects all the special senses, and produces anæsthesia or impaired sensibility of the various mucous outlets. 6. All the poisonous effects are produced by very large doses, as from the bromide of potassium, but in smaller doses it is more certain and reliable, causes no

diarrhoea or diuresis, nor anaphrodisiasis, and its special properties are exerted sooner and with less inconvenience.

“On the Physiological Properties of the Nitrate of Amyle.” By Dr B. W. RICHARDSON.—The nitrate when inhaled produces an immediate effect on the heart, increasing the action of the organ more powerfully than any other known agent. As the action of the heart rises, the surface of the skin becomes red, and the face assumes a light crimson colour. Carried to an extensive degree, the nitrate excites the breathing, and produces a breathlessness like that caused by sharp running or rowing. On animals, when the agent is given in large doses, it produces death. The most remarkable effect produced by the nitrate was, that in the lower animals and frogs it led to suspended animation, which could be maintained for so long a time as nine days with perfect after-recovery.

“On the Blood in Relation to the Question, Is Ammonia one of its Normal Constituents?” By Dr DAVY.—The conclusions he arrived at are the following:—1. That they are confirmatory of the inference that the coagulation of the blood is not owing to the escape of ammonia. 2. That they are favourable to the conclusion that the blood generally contains a small proportion of ammonia. 3. That the ammonia which is found in the air, respired in respiration and in insensible cutaneous perspiration, is derived from the blood, and is yielded in union with carbonic acid. 4. That the proportion of the volatile alkali is greater in venous than in arterial blood. 5. That in the blood of the Batrachians, and of other animals in which the aeration of this fluid is less perfect than in birds and mammalia of higher temperature, the quantity of the alkali is proportionally greater.

“On the Reason why the Stomach is not Digested by its own Secretion during Life.” By Dr PAVY.—How is it that the stomach, composed as it is of digestible materials, escapes being digested itself, whilst digestion is being carried on in its interior? The question here raised must be admitted to be one of the utmost interest and importance to us all, because it touches upon the means by which we escape after every meal we consume from the occurrence of an event which would inevitably prove fatal to life. Hunter noticed that the stomach was susceptible of being attacked by the digestive liquid after death, and accounted for its power of resisting destruction during life by reference to the “living principle.” This statement, however, fails to stand the test of actual experiment. The “living principle” must be discarded, as insufficient to account for the state of security under which the living stomach exists. To replace the refuted influence of the “living principle,” it has been suggested that it is the epithelial lining which gives to the stomach the immunity from destruction it enjoys during life. This view, however, like Hunter’s “living principle,” fails to stand when submitted to the test of experiment; for I have found that a considerable-sized patch of mucous membrane may be removed, and food will afterwards be digested without the slightest sign of attack being made upon the deeper coats of the organ. The problem, therefore, as to why the stomach is not susceptible of attack during life, as it is after death, still remains open for solution; and the view that I have to offer refers the immunity observed to the circulation within the walls of the organ of an alkaline current of blood. It will not be disputed that the presence of acidity is one of the necessary circumstances for the accomplishment of gastric digestion. Now, alkalinity is a constant character of the blood, and as, during life, the walls of the stomach are everywhere permeated by a current of this alkaline blood, we have here an opposing influence, the effect of which

would be to destroy, by neutralizing its acidity, the solvent properties of the digestive fluid tending to penetrate and act upon the texture of the organ. The blood being stagnant after death, the opposing influence is lost that is offered by the circulating current. Should life happen to be cut short at a period of digestion, there is only the neutralizing power of the blood actually contained in the vessels of the stomach, to impede the progress of attack upon the organ itself; and the consequence is, that digestion of its parietes proceeds, as long as the temperature remains favourable for the process, and the solvent power of the digestive liquid is unexhausted. There is therefore no want of harmony between the effect that occurs after death, and the explanation that refers the protection afforded during life to the neutralizing influence of the circulation.

“On the Renal Organ—the so-called Water System—in the Nudibranchiate Molluscs.” By Mr ALBANY HANCOCK.

“On the Renal Organ of the *Aplysia*.” By Professor ROLLESTON.

“On Cranial Deformities, more especially on the Scaphocephalic Skull.” By WILLIAM TURNER, M.B.

“On Life in the Atmosphere.” By JAMES SAMUELSON.—The author described the occurrence of living germs in great quantity in the dust conveyed by the atmosphere and in distilled water, and showed that these germs retained their vitality for a long time under various vicissitudes. He opposed the theory of spontaneous generation; and he suggested whether the great rapidity with which these germs are multiplied might not account for the spread of epidemic diseases.

“On the Means of Passing Unharmed through Noxious Gases or Vapours.” By Dr WHITE.—Dr White remarked—The apparatus which I have had constructed for “enabling a person to breathe in noxious gas” differs essentially from any heretofore used. If any person will keep his mouth closed, and by closing and opening either nostril so that he shall inhale by one alone, and exhale by the other alternately, and then insert a pipe into the nostril by which he inhales, he will understand the method of breathing with my apparatus as soon as it is described. It consists of two pipes fixed in a metal covering, which is placed over the nose and mouth. Each of these pipes is furnished with a valve of vulcanised india-rubber, one of which is fixed so that it can be moved only inwards, and the other only outwards. These valves are elastic, and of so light a material that they are opened and shut by the force of the air, moved to and fro in the act of breathing; and, therefore, when the air passes through these pipes the person inhales only through one pipe, and exhales through the other. Having the end of that by which he breathes in a pure atmosphere, the air which enters the lungs is pure, though the person is surrounded by noxious vapour. This inhaling pipe may draw its supply from the open air at any distance from the body, or it may be supplied from a bag carried on the body. By this plan the supply is limited to the size of the bag; by the other the supply is only limited by the length of his inhaling pipe. Sometimes one method and sometimes the other will be most convenient. The exhaled air passes through its pipe into the surrounding foul atmosphere. The flexible valve of the exhaling pipe completely prevents ingress of the surrounding gas; and therefore the pipe is short; it need not be more than half an inch in length. The part of the apparatus which I have described, and which I will call the “orinasal cover” and air pipes, is fixed in that part of a hood which covers the face. A tippet, made of water-proof cloth, is joined to the hood. Two circular pieces of glass are fixed in the hood for

enabling the man to see. Every part of this air-proof hood where the metal is fixed is water-tight. When this apparatus is about to be used, a soft, thick kerchief is to be wrapped smoothly round the neck. The hood and tippet is then put on. A band having been bound round the head and face over the hood, to keep the orinasal cover in its place, with a kerchief bound round the neck over the tippet, to prevent any foul air passing under it, the waistcoat and coat should then be buttoned and secured over the tippet for the same purpose. The means are so simple, and seem so slight, that a man may naturally hesitate to enter a poisonous gas with such protection; but if the apparatus be water-tight (which should be tested by trial with water, just before using it) he need not fear; for I have tried it repeatedly in the fumes of burning sulphur, in the sight of many witnesses, and it has never failed me. When the apparatus is used with an inhaling pipe extending into the pure air, the end may be fixed there, or held by an assistant, and conversation at the same time can be carried on between the wearer and his assistant through the pipe. When it is used in this manner a cord may be fastened round the person using the apparatus, and the other end held by the assistant outside, so that the man may be hauled out, if, through any accident, such a proceeding should be necessary. When the apparatus is used with an air-bag, it is attached to the back, and one end of the inhaling pipe communicates with it. A smaller air-bag is also connected by means of its own pipe, having a stop-cock, with the common inhaling pipe. The use of this small air-bag is, that the man may have its contents in reserve as soon as his larger store is exhausted; that he may know it is time to replenish his bags when his larger bag is empty. It might be useful to have one or more bags of air furnished with stop-cocks, and proper unions kept in reserve in places such as coal mines, where they may be required, so that a man using the apparatus could attach a full bag to it when necessary. I again state that it is necessary to examine the apparatus before using it, and to fix it on carefully; for if a man should enter carbonic acid gas with it, and through any imperfection of the apparatus shall inhale for some time a poisonous gas (though only a small quantity), he may fall down insensible, and may lose his life, unconscious of his danger.

“On the Practicability of Arresting the Development of Epidemic Diseases by the Internal Use of Anti-zymotic Agents.” By Dr ROBINSON.

“On the Physiological Effect produced by several apparatuses contrived for the purpose of causing a Vacuum upon the entire body, or a part thereof.” By Dr JUNOD.—Several important effects had been produced, and among them the power of occasioning syncope at will, and thereby producing the condition most likely to arrest inflammation without the loss of power consequent upon the abstraction of blood. Besides the apparatus for an exhausting effect, Dr Junod proposed the converse of this remedial influence, and applied compressed air. For this purpose a large air-tight chamber is used, having the form of a diving-bell. The patient is seated within, and air forced in until the necessary amount of pressure is produced—say of two, three, or more atmospheres. In the numerous experiments made of this treatment, it would appear that in the proportion that the powers of vitality are diminished in the method of exhaustion, they are increased and rendered more active by that of compressed air. The kind of maladies which have been relieved or cured by the latter process are precisely those in which an atonic condition of the system exists.

“On the Dietary of the Lancashire Operatives.” By Dr EDWARD SMITH.

"On the Coal Miners of Durham and Northumberland, their Habits and Diseases." By Dr WILSON.

"On the Dietaries of the Labouring Classes." By Dr EDWARD SMITH.

"On the Calabar Bean." By Mr THOMAS NUNNELLY.

"On a Parasitical Acarus of the Anodon." By Mr R. GARNER.

"On a Miners' Safety-mask for supporting Life in Fire-Damp and other Noxious Vapour." By Mr B. W. RICHARDSON.

"On How to restore Drowned Persons, Patients in Chloroform Accidents, &c." By Dr KIDD.

"On the Normal Position of the Epiglottis." By Dr GEORGE D. GIBB.

"On Voluntary Closure of the Glottis, independently of the Act of Breathing." By Dr GEORGE D. GIBB.

"Note on the Change of Attitude which takes place in Infants beginning to Walk." By Dr CLELAND.

"On the Reciprocal Action between Plants and Gases." By Mr R. GARNER.—In this paper the author brought forward the subject of the natural inhalations and exhalations of plants, and of the effects on vegetation of certain non-natural contaminations of the atmosphere, such as occur in coal and mining districts, consisting for the most part of sulphurous and hydrochloric acids, and of ammonia. Different plants have different susceptibilities for such influence, and a kind of rude metrical table may be constructed, in which the greater or less impurity of the atmosphere may be shown from the effects on plants. Thus the rhododendron, or yucca, or aucuba will flourish in an air fatal to the common laurel; wheat will luxuriate when a holly or oak will die. Annuals suffer least, evergreens much. The paper gave the result of many experiments on plants by means of gases, &c., applied to the leaves and roots. Some plants which appear naturally to luxuriate in the coal strata, as the oak, holly, or some ferns, soon die, he stated, when the mines began to be worked. Trees lose their leaves earlier than in other districts, and, as a rule, evergreens suffer much. One thing was fortunate: annuals suffer less, for instance, corn and wheat do well when nothing else could, and perhaps the exhalations in question might even tend to ripen them.

"On the Physiological Action of the Uterus in Parturition." By Dr DONKIN.

"On the Condition of the Uterus after Delivery in Certain of the Mammalia." By Professor ROLLESTON.

"On the Ligamentous Action of the long Muscles in Man and other Animals." By Dr CLELAND.

SECTION E.—GEOGRAPHY AND ETHNOLOGY.

President—Sir R. I. MURCHISON.

"Proposed Inter-Oceanic and International Transit Route across Central America." By Captain BEDFORD T. PIM.

"Journey from Tientsin (North China) to the Capital of Mantchu Tartary." By Captain G. FLEMING.

"On the Commixture of the Races of Man as affecting the Progress of Civilisation in the New World." By Mr J. CRAWFURD.

"On Anthropological Classification." By Dr J. HUNT.

"A few Notes on Sir Charles Lyell's Antiquity of Man." By Mr JOHN CRAWFURD, F.R.S.—While the author agrees with Sir Charles Lyell as to the great antiquity of the appearance of man on the earth, he objects to his view of the unity of the human race and his doctrine of transmutation. He also differs from him as to the origin of languages. In speaking of Professor Huxley's views, he expresses his conviction that whatever actual resemblance there may be between man and apes, they are completely removed from each other in most important particulars.

"Geographical Notes on the Island of Formosa." By Mr ROBERT SWINHOE, Vice-Consul at Taiwan.

"Some Facts respecting the Great Lakes of North America." By Mr J. A. LAPHAM, of Milwaukee, Wisconsin, U.S.

"On the Physical and Mental Characters of the Negro." By Dr JAMES HUNT.—The general deductions which he attempted to draw were—1st, That there is as good reason for classifying the Negro as a distinct species from the European, as there is for making the ass a distinct species from the zebra. 2d, That the Negro is inferior intellectually to the European. 3d, That the analogies are far more numerous between the Negro and apes, than between the European and apes.

No man, he said, who investigates with an unbiassed mind, can doubt that the Negro belongs to a distinct type of man from the European. This word species, in the present state of science, is not satisfactory; but we may safely say that there is in the Negro that assemblage of evidence which would, *ipso facto*, induce an unbiassed observer to make the European and Negro two distinct types of man. My second and third proposition must be equally patent to all who have examined the facts.

We must, for the present, leave apart all questions of the origin of the Negro, and simply take him as he exists, and not as poets or fanatics paint him. We shall then learn, that it is only by observation and experiment that we can determine the exact place in nature which the Negro race should hold, and that it is both absurd and chimerical to attempt to put him in any other.

Mr CRAFT said that though he was not of pure African descent, he was black enough to attempt to say a few words in reference to the paper which had just been read. With regard to the origin of the Negro, he for one believed that black and white men were all descended from a common parent. As Africans were very dark, and the inhabitants of Northern Europe very fair, and as, moreover, the nations of Southern Europe were much darker than those of Northern Europe, it was perfectly fair to suppose that climate had a tendency to bleach as well as to blacken. The thickness of the skull of the Negro had been wisely arranged by Providence to defend the brain from the tropical climate in which he lived. The woolly hair was not considered by Africans as a mark of inferiority, though some of them shaved it off, but it also answered the purpose of defending the head from the sun. He had recently been to Africa on a visit to the King of Dahomey. He found there considerable diversities even among the Africans themselves. Those of Sierra Leone had prominent, almost Jewish features. Their heels were quite as short, on the whole, as those of any other race, and upon the whole they were well formed. Persons who had any knowledge

of Africans knew that, when they enjoyed advantages, they were capable of making good use of them. He might refer to the instance of the little girl brought to this country by Captain Forbes. This child was presented to the Queen, who had her carefully educated. When she grew up, she mingled in good society, and interested every one by her proficiency in music, and recently she had been married to a commercial gentleman of colour at Lagos. Another case was mentioned by Mr Chambers in one of his works, and another case was that of Mr Crowther, who was well-known to many gentlemen in this country. One word with reference to the ancient Britons. When Julius Cæsar came to this country, he said of the natives that they were such stupid people that they were not fit to make slaves of in Rome. It had taken a long time to make Englishmen what they now were, and therefore it was not wonderful if the negroes made slow progress in intellectual development. It was, however, proved that they made very rapid progress when placed in advantageous circumstances. He pointed to Hayti as furnishing an instance of independence of character and intellectual power on the part of the Negro; and contended that in America the degraded position which he was forced to occupy gave him no chance of proving what he really was capable of doing. He was sorry that scientific and learned men should waste their time in discussing a subject that could prove of no benefit to mankind. He spoke with great deference to their opinions, but, for his own part, firmly agreed with Cowper, that

Fleecy locks and black complexion
 Cannot alter nature's claim;
 Skins may differ, but affection
 Dwells in white and black the same.

Professor WILSON claimed for the author of the paper and those gentlemen who supported him, the credit of being influenced by a desire to search out facts which could throw light on the important subject under discussion. At the same time he differed considerably from them in some of their conclusions. It was very important to have sufficient data before forming a theory, and he thought that Sir Charles Lyell and others, who contended that the intellectual progress of the Negro stopped at the age of fourteen, had fallen into the error which a person would who went into a workhouse among the most degraded and wretched of its occupants to find intellectual culture and capacity. The fact was that very few, if any, black children had any opportunity of pursuing their education after the age of fourteen; and in addition to that drawback, they had the misfortune to belong to a degraded and oppressed class, which was crushed and held down in the social world. The wonder was, that any of these unfortunate people had energy enough to make their escape and to acquire knowledge sufficient to enable them to carve a way for themselves through life, as not many of them did. The English character was made up of many elements, but a few hundred years ago the inhabitants of this island were cruel, unlettered, barbarous people. When put under good training and subjected to certain influences, the Anglo-Saxon proved capable of remarkable development, owing chiefly to the native energy of his character. The same quality was observable in some tribes of the present day, such as the New Zealander; and it was not wise, therefore, to argue as though the absence of combination denoted a natural and primary inferiority of race.

“On the Indian Tribes of Vancouver's Island.” By Captain EUSTACE W. JACOB.

“On some Curiosities of Physical Geography in the Ionian Islands.”—By PROFESSOR ANSTED.

“On a Central Argentine Railway from Rosario to Cordova, and across the Cordillera of the Andes.” By W. WHEELWRIGHT.—The Central Argentine Railway commences at the city of Rosario, in the province of Santa Fe, on the right bank of the La Plata, in the latitude of $32^{\circ} 56'$ southward, the longitude of $61^{\circ} 30'$ west, and about 250 miles above Buenos Ayres by the channel route, which is navigable for ships of a large size, and has a depth of 16 feet of water; it possesses a very fine harbour, and all the elements of prosperity, and is the great commercial *entrepôt* of the interior provinces. Here the steamers which ply between Monte Video, Buenos Ayres, and Paraguay, and those engaged in commerce with Corrientes and other commercial points, stop, while almost a daily intercourse by steamers is kept up between this port and Buenos Ayres. From Rosario the railway will pursue its course in a north-west direction over those vast and fertile plains to Cordova, the central city of the plains, 247 miles, and thus will form the great trunk line, having upon its south and west the provinces of Mendoza, San Juan, San Luis, and the interior of the province of Buenos Ayres, whose high roads all concentrate upon the line of railway about midway; on the north are the provinces of Tucuman, Santiago del Estero, Jujury, Catamarca, and Rioja, with all their roads concentrating at Cordova, and thus forming one of the most extraordinary combinations to be found in the annals of railways.

“On the Physical Geography of Guatemala.” By M. OSBERT SALVIN.

“On the Manganza in Africa.” By the Rev. L. J. PROCTOR.

“On the so-called Celtic Languages in Reference to the Question of Race.” By Mr JOHN CRAWFURD.

“On Celtic Languages.” By Mr R. S. CHARNOCK.

Mr Crawford argued that the Gaelic and Welsh languages were quite distinct, while Mr Charnock took an opposite view.

“On some Points in the Cranioscopy of the Nations of South America.” By Mr C. CARTER BLAKE.

“On the Gulf Stream and the Influence of Atmospheric Currents.” By Captain MAURY.

“On his Travels with Captain Speke from Zanzibar to the Sources of the Nile.” By Captain GRANT.

“A short Account of old Maps of Africa, placing the lakes (Nyanza and Tanganzika) nearly in their true positions.” By Mr JOHN HOGG.

“An Account of his Disasters in ascending the Nile.” By Vice-Consul PETHERICK.

“On his Travels towards the Sources of the Nile.” By Signor MIANI.

“On his Exploration of certain Affluents of the Nile.” By Baron von HEUGLIN.

“The Ethnology of Ceylon, referring especially to its Singhalese and Tamil Inhabitants.” By MUTU COOMARA SWAMY.

“On the Varieties of Man in the Malay Archipelago.” By Mr ALFRED WALLACE.—In the Malay Archipelago are found two very strongly contrasted races—the Malays and the Papuans. The former inhabit the great Western Islands—Sumatra, Java, Borneo, and Celebes; the latter, New Guinea and the adjacent small islands. The typical Malays are of a light brown colour, resembling cinnamon or lightly roasted coffee; they have constantly straight black and rather coarse hair, little or no beard,

and generally smooth hairless bodies ; they are of a low stature, rather strongly made, with short thick feet, and small delicate hands. The face is broad, the eyebrows flat, the nose small, well formed, with the nostrils somewhat exposed ; the lips broad and well cut, the mouth large but not projecting. In character, the Malay is impassive, reserved, and bashful. His feelings of surprise, admiration, or fear, are not readily manifested, and he has little appreciation of the sublime or beautiful. He is somewhat taciturn, is deliberate when he speaks ; he but seldom laughs, nor does he openly express his gratitude for a favour. He revenges an insult more quickly than an injury. He is honest and trustworthy in many matters, but prides himself upon his capacity of lying. His intellect is but mediocre, he is deficient in the energy necessary to acquire knowledge, and his mind seems incapable of following out any more than the simplest combinations. He is quick in acquiring mechanical arts, and therefore makes a good servant for simple routine duties. The Papuan is in many respects the opposite of the Malay. In colour he is a deep sooty-brown or black ; his hair is very peculiar, being harsh, dry, and frizzly, growing in little tufts, which in youth are short and compact, but which in adults often grow out so as to form a compact frizzly mop, nearly a yard in diameter. He is bearded, and his arms, legs, and breast, are more or less hairy. The Papuan is taller than the Malay, and perhaps equal to the average of Europeans ; the face is elongate, and the hands and feet rather large ; the forehead is flat, the brows very prominent, the nose large, long, and arched, with the nostrils hidden by the overhanging tip. The face has thus a Semitic character, which is perceptible even in the children. The moral characteristics of the Papuan separate him widely from the Malay. He is impulsive and demonstrative in speech and action. His emotions and passions are expressed in shouts and laughter, in yells and frantic leapings. He is noisy and boisterous in speech and action, both at home and before strangers. Of his intellect less is known, but it seems at least equal and probably superior to that of the Malay. He has a love of art, decorating his canoe, his house, and almost every domestic article with elaborate carving. It must be granted, therefore, that these two races are most strongly contrasted ; and if mankind can be classed at all in distinct varieties, the Malay and the Papuan must certainly be kept separate. Besides these well-marked races, are the inhabitants of the intermediate islands of the Moluccas and Timor, which, though differing in some degree from both, may yet, in almost every case, be classed with one or the other of them. The Negritos of the Philippines and the Lemangs of Malacca differ in most important characters from the Papuan races with which they have hitherto been classed, and must be considered to have Asiatic rather than Polynesian affinities. The recent evidence of the antiquity of man, and his having survived geological changes and the extinction of many species of mammalia, introduces a new element into ethnographical researches, and enables us to speculate more freely on the distribution and origin of races. Mr Darwin's researches on the structure and origin of the coral reefs of the Pacific, render it highly probable that great islands, or even continents, have recently sunk beneath its waters. The present distribution of animals in the Pacific islands leads us to conclude that this subsidence is geologically recent. The inhabitants of all the Pacific islands as far west as New Guinea and Australia have much in common, while they differ greatly from other races. Combining these facts, and boldly following their indications, we may divide the Malay Archipelago by a virtual waving line through the Moluccas, so that all the tribes to the west of the line will be Malayan and of Asiatic origin, and all to the east Papuan or of Polynesian origin. This division is in

harmony with that which has been shown to exist in the animal productions of the same regions, and obviates the difficulties attending every theory hitherto proposed as to the affinities and derivation of the Malayan and Polynesian races.

"On the Recent Discovery of Lacustrine Human Habitations in Wigtonshire." By Lord LOVAINE.

"Two Ascents of the Volcano of Misti." By the Hon. R. MARSHAM.

"On the Rivers of the Interior of Australia." By Rev. J. E. WOOD.

"Ethnology of Eastern Mantchuria." By Captain FLEMING.

"On the Human Cranium found at Amiens." By Mr HENRY DUCKWORTH.

"On the Anatomical Characters of the Human Cranium found at Amiens." By Mr WILLIAM TURNER.

"On the Tribes, Trade, and Resources around the Shore Line of the Persian Gulf." By Colonel PELLY.

"On the Commixture of the Races of Man as affecting the Progress of Civilisation in Eastern Asia and the Polynesian Islands." By Mr J. CRAWFURD.

"On his Visit to Dahomey." By Mr CRAFT (an African Gentleman).

"On the Aboriginal Occupation of North Tynedale and Western Northumberland. An Illustration of the Social Life of the Northumbrian Celts." By Rev. G. R. HALL.

"The Origin of Gipsies." By Mr J. CRAWFURD.

"Antiquities of the Orkneys." By Mr GEORGE PETRIE.

"Notice of the Discovery of Three additional Runic Inscriptions in St Molio's Cave, Holy Island, Argyleshire." By Professor DANIEL WILSON.

"On Ethnographical Casts." By HERMANN DE SCHLAGINTWEIT.

"Ethnology of the Island of Formosa." By Vice-Consul SWINHOE.

"The Extinction of Races." By Mr RICHARD LEE.

"Note upon the Opening of a Cist of the Stone Age near the Coast of the Moray Firth." By GEORGE E. ROBERTS and Professor BUSK.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

President—Mr W. TITE.

"On the Vital and Sanitary Statistics of our European Army in India, compared with those of the French Army under like Conditions of Climate and Locality." By Dr J. BIRD.

"On the Coventry Freehold Land Society." By Mr C. H. BRACEBRIDGE.

"On the Decrease of the Agricultural Population of England, A. D. 1851-61." By Mr PURDY.

"On the Effects of the Recent Gold Discoveries." By Mr H. FAWCETT.

"On the Opening and Extension of Durham University Academical Endowments." By Mr HEYWOOD.

"On the Sanitary Condition of the Troops in India." By Dr CAMPS.

"On Transportation in connection with Colonisation." By Colonel TORRENS.

"On Mortality in Lancashire." By Mr FREDERICK PURDY.

"Remarks on Native Colonial Schools and Hospitals, from the Sanitary Statistics of Miss Florence Nightingale." By Mr JAMES HEYWOOD.

"Statistics of the Tanning Trade of Newcastle-on-Tyne (communicated by Mr JAMES POTTS). By the late Mr T. C. ANGUS.

"Military Budgets of English and French Armies, for 1863-4, Statistically compared." By Colonel SYKES.—He showed by a series of elaborate returns that the total effective English army was 147,118; that of the French, 355,187: the cost per head of the effective and non-effective English, numbering 147,118 men, was £94, 1s. 1½d., while the French effective and non-effective forces, of 400,000, was £43, 9s. 4d. per head. The cost of the British manufacturing department was £6, 10s. per head, against £2, 15s. 10d.; military stores (British) per head, £5, 14s., French, £3, 0s. 2d.; purchase of small arms (British), 14s. 4½d., against 5s. 8d.; British military education, £1, 3s. 5d., French, 7s. 1d.; administration of the British army (Secretary of State and Commander-in-Chief's department), £1, 8s. 11d., French, 6s. 11½d.; Government staff (British) per individual, £304, 5s., French, £390; clothing (British), £4, 0s. 2d., against £1, 19s. 11d. French.

"Report of the Committee on Technical and Scientific Evidence in Courts of Law." By Mr THOMAS WEBSTER.

"A Statistical Account of the Parish of Belingham." By Mr WILLIAM HENRY CHARLTON.

"On the Difference between Irish and English Poor Law." By WILLIAM NEILSON HANCOCK, LL.D.

"The Statistics connected with the Architectural Improvements in the City of Paris." By Mr WILLIAM TITE.

"The Volunteer Force; its Comparative Cost, Development, present State, and Prospects." By Mr HENRY C. ALLHUSEN.

"On the Origin of the Stockton and Darlington Railway." By Mr W. FALLOWS.

"Observations on Criminals." By Mr THOMAS ROBINS.

"On the Reduction of the Death-rate in Gateshead by Sanitary Measures." By Mr JOHN LAMB.

SECTION G.—MECHANICAL SCIENCE.

President—Rev. R. WILLIS.

Mr C. T. PORTER read a paper describing "Richards's Indicator for Steam-Engines."

Mr P. WESTMACOTT read a paper, prepared by himself and Mr J. H. SPENCER, "On the Engineering Manufactures of the Tyne and Neighbouring Districts."

Mr J. JAMIESON described a new form of Air-Engine of his invention.

A paper by Messrs HAWTHORN, describing their new method of working railways by stationary engines, was read.

"On a New Plan for Hanging Dock-Gates." By Mr R. A. PEACOCK.

Mr G. FAWCUS described a plan for building boats so that any number may be packed one within the other, thus enabling a larger number of boats to be carried on board ship, and effecting a great economy of room.

Mr D. PUSELEY read a paper descriptive of Thompson's Universal Stopper for bottles, casks, &c.,—an ingenious and effective mechanical arrangement for this purpose, by which many of the inconveniences from the use of corks are obviated.

Mr W. H. RICHARDSON read a paper "On the Paper Manufacture of Northumberland and Durham."

Mr C. W. SIEMENS then described his Regenerative Gas Furnaces for Iron Works.

Mr D. D. MAIN described the Newcastle and Gateshead Water-supply.

Admiral Sir E. BELCHER described a Spirit-level Telescope for observing altitudes and obtaining latitudes independently of natural or artificial horizons, and exhibited a telescope thus constructed.—This telescope carries within itself a spirit-level, the bubble of which is brought to the level wire to which the object is brought.

The Abbé MOIGNO exhibited and explained an instrument invented by Messrs Bourdon and Salleron, termed "Injecteur des Corps solides." The instrument is well adapted for the lecture-table, and illustrates in a remarkable manner the apparently paradoxical action of Gifford's Injector, now so largely used as a self-acting fuel-supplier for steam-engine boilers.

"On Extinguishing Fires." By Mr C. B. KING.

"On the Prevention of Fouling of Ships' Bottoms." By Dr WHITE.—The composition proposed for the covering of iron ships' bottoms is made of equal parts of powdered quick lime, of fat, and of oil, mixed and rubbed together. It is laid on the first time, when cold, by means of a short-haired painter's brush, on the surface, while high and dry; but when afloat it must be applied by means of a diver's hand, either naked or covered with a glove. This composition is a kind of soap, which is insoluble in water, and which undergoes a slow chemical change, the result of which is that, after a few months, it has become rather less soft, and more easily separable in the form of flakes or scales from the submerged surface of the ship than it was when fresh applied.

"Self-acting Valve Motion for Steam-Hammers." By Mr JOHN STURGEON.

"Iron Ship-Building on the Tyne and Neighbouring Districts." By Mr C. M. PALMER.

"Description of the large Gyroscope used by Sir William Armstrong in the invention of Rifled Projectiles." By Professor POLE.

"On Skin Resistance as Affecting the Speed of Ships." By Professor RANKINE.

"An Investigation of Plane Water Lines for Ships." By Professor RANKINE.

"The Diagonal Principle of Iron Ship-Building." By Mr ROBERT TAYLORSON.

"A Mode of rendering Timber-built Ships impregnable and unsinkable under moderate Crew-power, as in a leaky vessel." By Admiral Sir EDWARD BELCHER.

"On an Improved Caisson Gate." By Admiral Sir E. BELCHER.

The Abbé MOIGNO exhibited the "Ventilateur à réaction" of Mons. Perigault de Rennes, and the "Balance aerostatique" of Mons. Seiler.

"Improvements in Waggons and Gun-Carriages." By Mr GEORGE FAWCUS.

"On Bridge Foundations." By Mr THOMAS PAGE.

"An Improved Valve and Apparatus for Atmospheric Railway Propulsion." By Mr W. SMITH.

"A novel method of covering Boilers, Pipes, and Cylinders of Steam Engines, for preventing the Radiation of Heat." By Mr W. SMITH.

“On Boiler Explosions.” By Professor AIRY.

“On the Improvements now being carried out in the River Tyne.” By Mr J. F. URE.

“On Targets for Gunnery Experiments.” By Captain DOUGLAS GALTON.

“On Rifled Ordnance.” By Mr GEORGE RICHARDS.

“On the Decortication of Cereals.” By Mr ROBERT DAVIDSON.

“On Improvements in Machinery and Apparatus for Cleansing and Purifying Casks.” By Mr ROBERT DAVIDSON.

“The Application of Machinery to Coal-Cutting.” By Mr SAMUEL FIRTH.

“Caselli’s Auto-Telegraph from Paris to Marseilles.” By the Abbé MOIGNO.

“Oudry’s Galvano-Copper and Galvano-Copper Paint applicable to Buildings, Armour Plates for Ships, &c.” By the Abbé MOIGNO.

“Report of the Committee on Steam-Ship Performances.” By Mr W. SMITH.

“Portable Machinery Apparatus for Rivetting, Chipping, &c.” By Mr W. SMITH.

“Novel Arrangement of Direct Acting Steam-Engines.” By Mr W. SMITH.

“Bown’s Tyre Fastening.” By Mr BENJAMIN FOTHERGILL.

Botanical Society of Edinburgh.

Thursday, 14th May 1863.—PROFESSOR MACLAGAN, President,
in the Chair.

The following Communications were read :—

1. *Descriptions of New Genera and Species of Diatoms from the South Pacific.* Part I. By R. K. GREVILLE, LL.D., F.R.S.E. With Plate.

(This paper appears in this volume of the Journal, p. 34.)

2. *Experiments on the Fertilisation of Orchids in the Royal Botanic Garden of Edinburgh.* By Mr JOHN SCOTT.

After some introductory remarks on hybridisation, and on Darwin’s experiments, the author says :—“ Having occasion to require a few capsules from the *Vandææ* tribe, I carefully fertilised for some time various species which flowered in the Royal Botanic Garden here. From certain of these I had the following somewhat singular and anomalous results. On different plants of the *Oncidium sphacelatum*, I fertilised a number of flowers with their own pollen, yet in no case did I ever succeed even in causing the capsule to swell. The only external signs the flowers afforded of being affected by the pollen were the closing of the stigmatic orifice twenty-four hours or so after its application, and the slightly earlier withering of the flower. On the large and vigorous plant of *O. sphacelatum*, which, along with others subsequently noticed, Mr M. Nab has kindly permitted me to place before the Society, I impregnated between

100 and 200 flowers, yet every capsule aborted. I dissected the column of many of these flowers as they dropped off, and invariably observed an abundance of pollen-tubes, which in most cases I traced into the ovary. Thus if the function of the stigma be simply to excite the emission of pollen-tubes, and that of the style their conduction to the ovary, we have evidence of its accomplishment, and might then attribute abortion to some inappreciable change in the sexual elements preventing normal conjunction.

"Having thus failed in fertilising *O. sphacelatum* with its own pollen. I determined to try crosses with other species. With this end in view, I first crossed it reciprocally with the neighbouring species, *O. altissimum*, under the impression that the probabilities for successful results would be inversely proportionate with the more or less immediate systematic affinities of the plants. In this my experiments have somewhat disappointed me; and the results of the above were the unexceptional abortion of every capsule. I next tried *O. graminifolium* with the pollen of *O. sphacelatum*, and succeeded in producing a capsule, which contained about one-fourth of embryonated seeds. I did not succeed *vice versa*. All the flowers thus treated dropped early. I may state that *O. graminifolium* does not appear from my experiments to be very susceptible of fertilisation with its own pollen.

"From four flowers of *O. ornithorynchum*, impregnated with the pollen of *O. sphacelatum*, I got one fine seed-capsule, though I had never before succeeded in fertilising this species with its own pollen; I have now a single capsule thus produced. On dissection of the crossed capsule, I was disappointed to find that it contained few seeds, and of these a great majority presented only a loose transparent testa, entirely destitute of the embryo. The capsule, on the other hand, fertilised with its own pollen, though not quite so large as the above, was quite filled with seeds, of which about three-fourths presented an embryo. I did not succeed in impregnating *O. sphacelatum* with pollen of *O. ornithorynchum*, though the capsules thus treated at first showed symptoms of swelling.

"The most successful experiments which I have made were with *O. divaricatum* var. *cupreum*, and *O. sphacelatum*. I impregnated six flowers upon the latter with pollen from the former; and I have now four fine capsules, nearly mature, as the result. I failed, however, in my attempts at crossing them reciprocally. I made also numerous attempts to impregnate *O. divaricatum* with its own pollen, and this as well upon those plants growing in baskets suspended in the hot-houses as those growing in pots. On one of the plants in the latter condition I have now, after many failures, succeeded in fertilising four flowers; the capsules, however, are very abnormal-looking productions. In one of them which I cut off for dissection, I did not find a single perfect seed. On the other hand, the results of experiments on plants growing in baskets, though the more natural mode of cultivating them, was, singularly enough, the abortion of every capsule thus impregnated. The only indications of pollinic influence were an earlier fading of the flowers, and the closing of their stigmatic orifices, which I may remark is in this case effected by a gradual depression of the clinandrium, instead of a simple incurvation of the wings of the orifice, as occurs in *O. sphacelatum*, mentioned above.

"Thus, in the above experiments, I have failed in crossing reciprocally any two species; nevertheless, I think I have satisfactorily shown an individual impotence of the sexual organs, in their mutual action, conjoined with a capability of normally performing their functions by the action of other species—and this in comparative disregard of recognised

systematic affinities. I have yet, however, another case to state, in which we are afforded an illustration of this reciprocal action of species. It occurred with the *Maxillaria atro-rubens* and *M. squalens*. On the former of these I had made numerous attempts to fertilise flowers with their own pollen, yet in every case they proved abortive. I was thus induced to try pollen from another species. I accordingly took a few pollen-masses from flowers of *M. squalens*—certainly a very dissimilar species, but the only one in flower at the time—with which I fertilised eight flowers of *M. atro-rubens*. These have afforded me very successful results, as six out of the eight have produced well-formed capsules. I next tried pollen from *M. atro-rubens* upon a flower of *M. squalens*, and have now succeeded in fertilising a capsule on the latter also. I may remark, however, that I have found this species perfectly productive when fertilised with its own pollen.

III. *On some New British Lichens.* By the Rev. T. SALWEY, B.D.,
Vicar of Oswestry, and formerly Fellow of the Linnean Society.

The following is a list of the Lichens described :—

1. *Aspicilia aquatica*, K  rber. 2. *Lecidea fusco-rubens*, Nyl. 3. *Lecidea lecanorina*, Nyl. (*Mischoblastia lecanorina*, Massalongo.) 4. *Lecidea lithophila*, Ach.; Nyl. Lich. Scand., p. 226. 5. *Lecidea tessellata*, Fl  rke. 6. *Lecidea Ph  eops*, Nyl. 7. *Squamaria galactina*, Pers. 8. *Verrucaria rudenum*, DC.; Fl. Fr., p. 318. 9. *Verrucaria athiobola*, Wahl. (*V. margacea*, var. 1, *athiobola*, Nyl.) 10. *Verrucaria virens*, Nyl. in Bot. Notes, 1853, p. 180. 11. *Calicium trajectory*, Nyl., nov. sp.

IV. *Synopsis of the Canadian Species of Equisetum.* By GEORGE LAWSON, LL.D., Professor of Chemistry and Natural History in the Queen's University of Canada.

The author gave descriptions of the species and their localities under the following sections :—

SECTION I. Stems annual, the sterile ones bearing verticils of soft green herbaceous branches; the fertile stems either evanescent and naked, or permanent and ultimately clothed with similar verticillate branches.

1. *E. sylvaticum*. 2. *E. umbrosum*. 3. *E. arvense*, and β . *granulatum*. 4. *E. Telmateja*. 5. *E. limosum*.

SECTION II. Stems perennial, silicious, not verticillately branched.

6. *E. hyemale*. 7. *E. variegatum*. 8. *E. scirpoides*, and β . *minor*.

V. *Register of Plants in Flower in the Open Air at the Royal Botanic Garden (4th List).* By Mr JAMES M'NAB, Curator.

The following shrubs and trees were in flower on the 20th day of April 1863. and they have not been enumerated in any of the previous lists laid before the Society at the above date :—

Pyrus Malus	Syringa persica	Forsythia viridissima
Prunus Padus	Crataegus pr��cox	Medicago arborea
Syringa vulgaris	Sambucus racemosa	Kalmia glauca

Fagus sylvatica	Acer rubrum	Pittosporum Tobira
Alnus glutinosa	— platanoides	Genista elongata and
— cordifolia	Azalea pontica	Wistaria sinensis—
Viscum album, mas	Daphne pontica	(wall)
Lonicera Xylosteum	Ribes aureum	Caragana frutescens
Cydonia japonica	— speciosum	Ulmus montana
Buxus sempervirens	Berberis Jamesoni	Fraxinus excelsior
Ilex Aquifolium	Viburnum vestitum	Double flowering
Euonymus europæus	Weigela rosea	cherry
Acer Pseudo-platanus		

Thursday, 11th June 1863.—T. C. ARCHER, Esq., Vice-President,
in the Chair.

The following Communications were read :—

- I.—On the Nature of the Perigynium or Utriculus of the Genus *Carex*.
By A. WESMAEL of the School of Horticulture of Vilvorde in Belgium.

The author remarks that Saint Hilaire and Lindley compare the utriculus of carices to the superior glumella or palea of grasses, and adopt the views of Brown, who considers the palea formed of two coherent bracts. Lemaout and Adrien Jussieu entertained the same opinion. The point to be determined is whether the axis bearing the secondary flower takes its origin laterally—and in that case either to the right or left, and opposite one of the two teeth which surmount the utriculus, and which correspond to the two median ribs of the two perigonial divisions of Lindley; or whether that axis is inserted in front of the ovary. After careful examination, M. Wesmael finds that the latter view is the correct one—viz., that the secondary axis is produced in front of the ovary. This is the view taken also by Kunth, Gay, Roper, and Schlechtendal.

The following are the conclusions at which he has arrived :—

“ 1. The utriculus which envelopes the ovary of the carices has been considered in two different ways.

2. According to the theory of Lindley, this utriculus is formed by the cohesion of two bracts, whilst, according to Kunth, it is formed by a single bract.

3. Lindley believes in the presence of two bracts, from the existence of the two ribs in the utriculus, which he thus regards as analogous to the two-keeled palea of grasses.

4. Lindley looks on the utriculus as being developed on an axis, which gives origin both to it and the ovary.

5. This theory does not give a true view of the nature of the racheole.

6. The racheole is a prolongation of the secondary axis, which, in an abnormal inflorescence of *Carex acuta*, after having given origin to the normal utriculus, is prolonged, and comes out in company with the stigma at the orifice of the utriculus; it then gives origin to the bract, and afterwards to the secondary utriculus; and on the axil of this is developed a very short axis, terminated by the ovary.

7. The racheole is not developed to the right or left of the ovary,—that is to say, in front of the one or the other of the two principal ribs of the utriculus,—but is prolonged in front of the ovary, and consequently between it (the ovary) and the parent bract.

8. The mode of development of the racheole does not favour the view of Lindley ; according to which it ought to have for its point of origin the axil of one of the two bracts constituting the utriculus.

9. The utriculus is an organisation analogous to that of the vaginiform bract which we observe at the base of the axis of inflorescence.

10. All the observations I have made are in favour of the theory of Kunth, and contrary to that of Lindley."

II.—*Photoglyphic Engraving of Ferns ; with Remarks.*

By H. FOX TALBOT, Esq., LL.D. (Plate VI.)

Dr Talbot remarked—This plate, representing a fern leaf, is done by the process which I have called photoglyphic engraving, and which was published a few years ago in the various photographic journals. It consists in covering a plate of steel or copper with a film of gelatine mixed with bichromate of potash, placing the object, in this instance a fern leaf, upon the plate, and exposing it to sunlight for a minute, then removing the object, dusting the plate with finely powdered resin, to give a grain to the engraving, melting the resin, and when the plate is cold brushing it with a camel's-hair brush dipped in perchloride of iron, which speedily penetrates the parts upon which the light has not acted, and effects an etching, while the parts exposed to sunshine are thereby rendered impermeable to the etching liquid. Such a plate (steel), thus prepared, is capable of yielding at least five thousand impressions. It will be remarked that the leaf exhibits no venation. This arises from its being a dried specimen from the herbarium ; but recent specimens, especially of *Adiantum*, *Trichomanes*, *Hymenophyllum*, &c., yield engravings with a very beautiful venation. Grasses also succeed remarkably well, and one of the most curious objects when engraved is the feathery achenes of *Leontodon Taraxacum* (the common dandelion), which are so well given as sometimes to be almost deceptive, except that the achenes themselves are apt to come out too black to be natural. If printed in pale brown ink, I think they would have a strong resemblance to nature. I wished to have shown a plate of this description to the Botanical Society, but the occurrence of cloudy weather for several days in succession has prevented my doing so on the present occasion.

If this art had been invented a hundred years ago, it would have been very useful during the infancy of botany, when communications with distant countries were so difficult. It would have been easy for botanical travellers such as Thunberg, Aublet, Loureiro, &c., to have taken with them a small printing-press, and to have worked off a small edition of fifty copies of each engraving they made, and sent the copies home to Europe whenever an occasion presented itself. Some of the copies would doubtless have escaped shipwreck and come to the knowledge of European botanists. Supposing the engraving only represented a leaf and a flower of each plant described in the works, it would have greatly aided modern botanists in determining the plants intended by those authors, whose descriptions are frequently so incorrect that they are like so many enigmas, and have proved a hindrance and not an advantage to science.

III.—*List and Localities of Rare Plants found in the vicinity of Perth.*

By Mr JOHN SIM, A.B.S. Ed.

IV.—*List of Plants found near the Rumbling Bridge.* By Professor
BALFOUR and Mr F. B. W. WHITE.

Ranunculus aquatilis.
——— *auricomus.*
Trollius europæus.
Aconitum Napellus.
Cardamine amara.
Stellaria nemorum.
Dianthus barbatus.
Geranium pratense.
——— *lucidum.*
——— *sylvaticum.*
Trifolium medium.
Vicia sylvatica.
Spiræa salicifolia.
Rubus saxatilis.
Epilobium angustifolium.
Circæa alpina.
Saxifraga hypnoides.
——— *umbrosa.*
Sedum reflexum.
Archangelica officinalis.
Viburnum Opulus.
Lonicera Periclymenum.
Hieracium prenanthoides.
Eupatorium cannabinum.
Petasites fragrans.
Matricaria Parthenium.
Carduus heterophyllus.
Campanula latifolia.
Ligustrum vulgare.
Symphytum officinale.
Veronica Anagallis.
Mentha sylvestris, β. velutina.
Calamintha Clinopodium.
Rumex aquaticus.
——— *sanguineus, β. viridis.*
Salix cinerea, β. aquatica.
Populus nigra.
Castanea vulgaris.
Paris quadrifolia.

Listera ovata.
Neottia Nidus-avis.
Sparganium ramosum.
Carex remota.
Carex sylvatica.
Milium effusum.
Melica uniflora.
Polypodium Phegopteris.
——— *Dryopteris.*
Lastrea Oreopteris.
——— *dilatata.*
Polystichum aculeatum.
——— *β. lobatum.*
Cystopteris fragilis.
Athyrium Filix-fœmina.
Asplenium Trichomanes.
Blechnum boreale.
Equisetum umbrosum.
Weissia verticillata.
Trichostomum flexicaule.
Zygodon Mougeotii.
Pogonatum urnigerum.
Polytrichum juniperinum.
——— *piliferum.*
Mnium rostratum.
——— *punctatum.*
Bartramia fontana.
——— *pomiformis.*
Anomodon viticulosus.
Isothecium myurum.
——— *alopecurum.*
Hypnum striatum.
——— *ruscifolium.*
——— *stellatum.*
——— *cupressiforme, β. compressum.*
Endocarpion miniatum.
Peltidea scutata.
Ramalina fastigiata.

Professor Balfour exhibited a collection of dried plants sent by the Rev. W. C. Thomson, Old Calabar, and read a letter which he had received from him, dated 28th March 1863, in which he says:—By this mail I send you some fire-dried specimens of our Flora, which I trust will be acceptable and prove interesting. For this simple and easy method of preparing them, such as they are, I am entirely indebted to my friend Mr G. Mann, who has been spending some time on the coast collecting for Kew. He visited us lately, and spent a few days with us; but unfortunately for us he leaves the coast by this mail, so that our Flora is not likely to figure so largely as it may deserve in the forthcoming volume on the Botany of Western Africa. I trust the specimens being sent will enable Edinburgh friends to contribute towards filling up the gap.

In the case are two parcels of Ndam. It is the epidermis of the leaf of the

Membo palm. All are dyed by boiling,—the black with the bruised leaves of *Mucuna Balfouriana*, the red with the bruised wood of a tree called Ukpa, and the yellow with the bruised bark of a tree called Auniau.

Mr W. W. Evans recorded the occurrence of *Helminthia echiioides*, a rare Scotch plant, by the side of a field at Tynefield, near Tynningham, where it has probably been introduced.

Thursday, 9th July 1863.—Professor BALFOUR, Vice-President,
in the Chair.

The following Communications were read :—

- I. *Descriptions of New Genera and Species of Diatoms from the South Pacific* By R. K. GREVILLE, LL.D., F.R.S.E., &c. Part II.

(The paper appears in the present Number of this Journal, p. 181.)

- II. *Description of the Fruit and Seed of Clerodendron Thomsonæ.* By Professor BALFOUR.

(The paper appears in the present Number of this Journal, p. 258).

- III. *Notice of a Botanical Excursion to Kielder and Deadwater Fell, Northumberland, on 4th July 1863.* By Professor BALFOUR.

Professor Balfour gave an account of a botanical trip to Kielder on Saturday, 4th July, with eighty pupils. The party went by the North British Railway to Riccarton, and thence by the Border Counties Railway to Kielder. They visited the woods near Kielder Castle, and proceeded by the Kielder Water to the mountains in the neighbourhood, ascending Deadwater Fell, which rises to the height of 1800 or 2000 feet. The numbers of species gathered were as follows :—

Flowering plants, ...	176
Ferns, Lycopods and Equisetums, ...	18
Mosses, ...	66
Jungermanniæ, ...	10
Lichens, ...	38
	308

Among the plants collected were the following :—

<i>Carduus heterophyllus.</i>	<i>Salix herbacea.</i>
<i>Aquilegia vulgaris.</i>	<i>Vaccinium Vitis-idæa.</i>
<i>Spiræa salicifolia.</i>	<i>Botrychium Lunaria.</i>
<i>Trollius europæus.</i>	<i>Scolopendrium vulgare.</i>
<i>Rubus Chamæmorus.</i>	<i>Hymenophyllum Wilsoni.</i>
<i>Listera cordata.</i>	<i>Cryptogramme crispa.</i>
<i>Habenaria viridis.</i>	<i>Polypodium Phegopteris.</i>
<i>Melampyrum pratense var. montanum.</i>	<i>Lastrea Oreopteris.</i>
<i>Veronica scutellata.</i>	<i>L. spinulosa.</i>
<i>Solidago Virgaurea.</i>	<i>L. dilatata var. alpina.</i>
<i>Corydalis claviculata.</i>	<i>Asplenium Ruta-muraria.</i>
<i>Sedum villosum.</i>	<i>Exidia auricula.</i>

Among the Musci, Hepaticæ, and Lichenes, which were determined by Mr John Sadler, were the following :—

Andræa Rothii.
Sphagnum cuspidatum var. *plumosum*.
Gymnostomum curvirostrum.
Campylopus longipilus.
Cinclidotus fontinelloides.
Racomitrium aciculare.
Pogonatum alpinum.
Bryum nutans.
Splachnum sphaericum.
Bartramia fontana.
Fegatella conica.
Jungermannia sphagni.

Boomyces roseum.
Lecanora tartarea.
Sticta pulmonaria.
S. sylvatica.
S. scrobiculata.
Peltidea scutata.
Cetraria glauca.
Alectoria jubata.
Sphærophoron compressum.
Stereocaulon paschale.
Cladonia uncialis.
Scyphophorus squamosus.
S. cocciferus.

IV. *Notice of Mosses found in Fifeshire.* By Mr CHARLES HOWIE.
 Communicated by Mr JOHN SADLER.

The author remarked that he had gathered 248 species and varieties of mosses in Fifeshire, some of them being very much restricted in their distribution.

Bankhead Moss, situated a few miles south of Ceres, is one of the few remaining portions of peat formation from which the country people cut peat for domestic purposes. It contains pools filled with water. In the larger and deeper pools we have *Sphagnum cuspidatum* var. *plumosum* in fruit, floating freely, bearing its fruit generally on lateral pedicels; *Sphagnum contortum* var. *subsecundum*, bearing fruit more sparingly; *Sphagnum cuspidatum* var. *recurvum* is generally associated in more dense masses in water of less depth. *Hypnum molluscum* is found by the sides of some of the deep ditches in fruit, and *Sphagnum cymbifolium* occurs with various tints of colour. *Sphagnum acutifolium*, *S. rubellum*, and *Hypnum fluitans* occur in fine fruit, in a pool of deep water, associated with *Sphagnum cuspidatum* var. *plumosum*. *Hypnum irriguum* grows in one of the small streams of the neighbourhood, and *Splachnum sphaericum*, on the naked peat soil. The Tents Muir is a station of peculiar interest in a Bryological point of view. *Bryum Marratii*, *B. calophyllum*, *Catoscopium nigrum* and *Distichium inclinatum* cover large patches of the Muir. *Amblyodon dealbatus*, with *Meesia uliginosa*, occurs densely covered with fruit. *Hypnum albicans*, *H. salebrosum*, *H. polygamum* and *H. lutescens* are also found in fruit. We also find *Bryum pseudotriquetrum*, *B. pallens*, and various other species more generally distributed, as well as *Climacium dendroides* and *Tortula vinealis* in fruit.

At Largo we come upon the basalt and trap which produce abundance of *Orthotrichum anomalum*, with a few examples of *O. saxatile*, *O. diaphanum*, and other species; *Grimmia leucophaea* and *G. Doniana* are also found. On Largo Law, *Grimmia apocarpa* is associated with *Pterogonium filiforme*, *Leucodon sciuroides*, and *Bryum crudum*. At Kilconquhar Loch specimens of *Mnium affine* var. *rugicum* occur in fruit; also *Hypnum cordifolium* in fruit. In the parts of the Links which are occasionally flooded by stream tides we meet with *Distichium inclinatum*, also *Hypnum abietinum* and *H. nitens*, *Encalypta rhabdocarpa* in considerable quantity and in dense fruit; further inland from the sea, *Tortula intermedia*, with *Orthotrichum anomalum* and *Hypnum lycopodioides*.

V. *Notice of some of the Woods used for Economical Purposes in New Zealand.* By Dr TUKE.

VI. *Notice of the Cinchona Cultivation on the Neilgherry Hills.*

By Dr Hugh Cleghorn.

The cultivation of Cinchona, or the Peruvian bark plant, is likely to supply a new produce for the trade of India. Mr Vincent, an enterprising planter, has secured 5000 Cinchona plants for the land he has purchased, and M. de Facien, an enterprising planter, has secured as many more. Altogether, the orders on record exceed the number of plants Mr M'Ivor (the superintendent of the Ootacamund garden) will be able to supply at the close of the current official year, which we understand will be 34,000. The plants available in the course of the next year, or from May 1863 to April 1864, are estimated at 100,000. This will be out of the Government nurseries, but the settings from their own stock, which planters in the meantime will have been able to rear, will be something considerable, for a single plant, some six feet high, in the public garden here, has given Mr M'Ivor no less than 900 cuttings, each the nucleus of a healthy sapling now, with the promise of a gigantic forest tree hereafter. The enormous source of wealth to which the Cinchona points, is actually derived from bricks. When a shoot is taken off a plant, it is immediately placed in a pot filled with brick dust. Hundreds, nay thousands of these pots may be seen in Mr M'Ivor's conservatories, covered with what look like nothing more than diminutive leaves thrust into them. Here the shoots are allowed to remain till they recover from the shock attending their severance from the parent stem. They are then transferred to pots charged with a mixture of decomposed felspar and garden mould, in which the process of rooting goes on. Several acres of shola land in the vicinity of the Government garden have been planted, and there can be no doubt that wherever the shade of a forest tree has fallen upon the interesting suckling below, it has pined and withered, or been stunted. The instances of this effect in a romantic glen to which Mr M'Ivor will cheerfully lead visitors are very remarkable. At a few yards from the umbrage of a group of trees, the plants look exceedingly flourishing, but their healthfulness, size, and vigour diminish in proportion to their approximation to shade. Some plants, which were put out in the Government garden in various positions a year ago, fully bear out this result. Those in the shade look sickly, and those subjected to drippings look worse. Mr M'Ivor does not consider the Ootacamund plantation a complete demonstration of his principles, that at Neddiwattum being more corroborative of his views; but any one knowing the difference between a healthy and a sickly plant, must at once acknowledge that shade is not the condition for the active development of the Cinchona. There are, of course, other important particulars connected with the ultimate success of the Cinchona in India which must be left to time and experiment to establish. We might mention the earliest period of growth at which the alkaloids begin to show themselves,—the efficacy of decoctions and infusions made from dry bark and leaves compared with their virtue when prepared with fresh specimens,—and the possibility of dispensing in a large measure, if not entirely, with the expensive manufactured article, quinine, in the event of bark and leaf possessing sufficient curative properties to be exhibited in most forms of fever disease. One or more of these points, accompanied with the requisite materials for arriving at correct results, will, we believe, be shortly submitted for decision in England. A very interesting feature in the habitude of the Cinchona plant is its power of reproducing its bark, when deprived of it, to a greater thickness than the original formation. This peculiarity, we learn, has been noticed by Mr M'Ivor, after covering the denuded parts with moss for a month

or two; but whether the larger volume of the bark thus produced will contain a proportionate excess of alkaloids, is a subject which at present rests in obscurity.

Professor Balfour read a letter which he had received from John Allan Broun, F.R.S., of the Trevandrum Observatory, Madras, in which he says:—"I used to botanise when in Scotland, and have always felt anxious to do something in that way among our unknown mountains, but my other pursuits have always prevented me. I tried to make a collection of a few plants, chiefly orchids, ferns, and mosses, but I had no good drying paper, only old newspapers, and it was very cloudy and damp, so that most of the flowering plants are spoiled. Could I have made out a collection worth anything, I would have sent you a set of the specimens. The finest palm of these mountains is the *Bentinckia Condapana*. I think it is the most graceful palm in Northern India. It grows chiefly in the clefts of precipices and among rocks not easily reached; but there are such forests of it on some slopes that we were kept from starving by cutting it down for the cabbage (young shoot), which is delicious. Raw, it is like the finest walnut; but we had it cooked as a vegetable and as a curry, when we had nothing else to eat. Its effect in the foreground in groups, and even in the distance of the landscape, is very fine. I have no book on palms, but I believe it is not found in the Neilgherries, nor do I know if it exists in Ceylon. It is found at a height of from 2500 to upwards of 5000 feet at the place where I have been, but I have no doubt it would grow at higher stations. I have brought down a few young plants to try to make it grow here. We have a museum here, of which I am honorary superintendent, and I tried to get up a botanic garden, but nothing has been done as yet. This climate is almost exactly that of the country of the *Victoria regia*, and I have a fine tank in which I could put it.

Mr F. Naylor presented specimens of *Briza maxima*, collected, apparently in a wild state, in Jersey.

SCIENTIFIC INTELLIGENCE.

BOTANY.

Report on the Bark and Leaves of Cinchona Succirubra grown in India. By J. E. HOWARD, Esq.—In order to make the best analysis of the small quantity of bark at my command, I commenced with 500 grains of that of the second year's growth, and was able to obtain therefrom a first and second crystallisation of white sulphate of quinine. By thus specifying the whiteness, I mean to imply that the bark had not the commercial disadvantage which frequently attends the "red bark" at a more mature stage of growth, resulting from the fact that the colouring matter has in these last become so much implicated with the alkaloids as to make the task of purification a difficult one. The crystallisations I obtained were mixed with some sulphate of cinchonidine, which is commercially (but not medicinally) a disadvantage, and one which always attends the products of "red bark." I also obtained cinchonine, and other usual products, of the process as from South American bark, viz., kinovic acid, kinate of lime, gum, cinchona red, &c. The product of alkaloid in a rough state was estimated at 4.30 per cent. A second trial of the same quantity enabled me to decide more accurately the per-centage product in *purified* alkaloids. I found the total contents 3.30 to 3.40 per cent., and of this (soluble in ether) quinine and some cinchonidine, 2.40 per cent.,

leaving '60 per cent. of cinchonine, which crystallised freely, and also '30 or '40 loss chiefly in water of the hydrated alkaloids. This result must be considered extremely favourable.

I have noticed the product of some fine quills of South American red bark as 3'60 per cent.,* the larger bark of the same parcel producing 3'91 of alkaloid. Dr Riegel obtained from 1 oz. red bark, of best quality, 4'16 per cent. by Rabourdin's process, or 3'90 by that of Buckner. Of this 2'65 per cent., soluble in ether, was reckoned as quinine, and the rest was set down as cinchonine.† I have obtained a much higher per-centage of alkaloid from large and peculiarly fine "red bark," but I see no reason to doubt that even this higher per-centage would be attained in the East Indies, if time were allowed for the growth.

The exact period at which it would be advisable to cut the bark must be ascertained by experiment, but I think this should take place as soon as the bark attains to a thickness which would repay the cultivation. There would be positive disadvantage in allowing the bark to attain such an age as is indicated by many of the specimens from South America, if the object to be attained is the extraction of the alkaloids; since there is a continual process of deterioration‡ of these after a certain period of the history of the bark, which is connected with the oxidation of the red colouring matter, and the production, in very old trees, of those fine descriptions of bright red bark which command, indeed, a high price in the market (as much at the present time as eight shillings per pound), but which would not, in many cases, be more valuable for the production of quinine than bark of one year's growth.

I next examined the younger bark of one year's growth, taking care to select the most mature portion, and found that it yielded 2'59 of alkaloid, of which 2'55 (soluble in ether) appeared to be quinine and cinchonidine, and in part crystallised into tolerably white sulphate, which showed perhaps a rather larger proportion of cinchonidine than in the older bark. On the other hand, the proportion of cinchonine seemed notably less, viz., only 0'04 per cent., but it is possible that the separation was not exactly effected between the cinchonine and cinchonidine, which is not easily accomplished by ether in such small portions.

The above result induced me to pay further attention to the leaves, concerning which the absence of any carmine sublimate by heat led me at first to an unfavourable conclusion. The decoctions and infusions made by Mr M'Ivor, though in perfectly good condition, showed that the contents changed most rapidly under the influence of the oxygen of the atmosphere as soon as ammonia was added to the, at first, decidedly acid liquor. Fortunately, a good supply of several ounces of dried leaves had been sent over, and from these I succeeded in obtaining quinine,§ though in very small quantity, but presenting its usual characteristics, dissolving in acids and precipitated by alkalies as a whitish hydrate, soluble in ether, and left by this on evaporation as a resinous-looking body, having the usual bitter taste, also crystallising not only as a sulphate, but as an oxalate of quinine (the latter being the more critical test), but nevertheless, presenting a characteristic implication with resinous or extractive matter such as is usually met with in the very smallest quills or *canutillos* of

* "Illustrations of Nueva Quinologia," under head *C. succirubra*, p. 15.

† "Pharm. Central-blatt," for July 1852.

‡ Described in my "Illustrations of Nueva Quinologia," under head *C. succirubra*, p. 14.

§ [This had been previously done by Dr T. Anderson, Superintendent of the Botanic Garden, Calcutta.—Ed. *Phil. Jour.*]

South American bark, in analysing which it is frequently difficult to purify the quinine from this adhesion. I obtained first from these leaves to the extent of 0.11 of alkaloid, of which part was soluble in ether, the remainder in spirits of wine, and afterwards 0.19 of precipitate still more combined with astringent matter. From these data, it seems to follow that the leaves will not supply a material for the extraction of quinine, but that they will, nevertheless, be very useful when used fresh or in recently prepared decoction or infusion for the cure of the fevers of the country. To this end the abundance of kinovic acid they contain, equal (weighed in the rough state) to 4.20 per cent., may also conduce.

MISCELLANEOUS.

Coagulation of the Blood.—Professor Lister, from recent experiments, concludes that the ammonia theory, however plausible, and though supported by many ingenious arguments and experiments, must be discarded as entirely fallacious. The coagulation is in no degree connected with the evolution of ammonia, any more than with the influence of oxygen or of rest. The real cause of the coagulation of the blood when shed from the body, is the influence exerted upon it by ordinary matter, the contact of which, for a very brief period, effects a change in the blood, inducing a mutual reaction between its solid and fluid constituents, in which the corpuscles impart to the *liquor sanguinis* a disposition to coagulate. This reaction is probably simply chemical in its nature; yet its product, the fibrin, when mixed with blood-corpuscles in the form of an undisturbed coagulum, resembles healthy living tissues, in being incapable of that catalytic action upon the blood which is effected by all ordinary solids, and also by the tissues themselves when deprived of their vital properties.—*Croonian Lecture, Royal Society, 1863.*

Sir William Armstrong on the Consumption of Coal in Britain.—The statistics collected by Mr Hunt, of the Mining Record Office, show that at the end of 1861 the quantity of coal raised in the United Kingdom had reached the enormous total of 86 millions of tons, and that the average annual increase of the eight preceding years amounted to $2\frac{3}{4}$ millions of tons. By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming 4000 feet as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than 2 feet in thickness, the entire quantity of available coal existing in these islands has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years, but, with a continued yearly increase of $2\frac{3}{4}$ millions of tons, would only last 212 years. It is clear that long before complete exhaustion takes place, England will have ceased to be a coal-producing country on an extensive scale. Other nations, and especially the United States of America, which possess coal-fields thirty-seven times more extensive than ours, will then be working more accessible beds at a smaller cost, and will be able to displace the English coal from every market. The question is, not how long our coal will endure before absolute exhaustion is effected, but how long will those particular coal-seams last which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing industry. So far as this particular district (Newcastle) is concerned, it is admitted that 200 years will be sufficient to exhaust the principal seams even at the present rate of working. If the production should continue to increase

as it is now doing, the duration of those seams will not reach half that period. How the case may stand in other coal-mining districts I have not the means of ascertaining; but as the best and most accessible coal will always be worked in preference to any other, I fear the same rapid exhaustion of our most valuable seams is everywhere taking place. Were we reaping the full advantage of all the coal we burnt, no objection could be made to the largeness of the quantity, but we are using it wastefully and extravagantly in all its applications. It is probable that fully one-fourth of the entire quantity of coal raised from our mines is used in the production of heat for motive power; but, much as we are in the habit of admiring the powers of the steam-engine, our present knowledge of the mechanical energy of heat shows that we realise in that engine only a small part of the thermic effect of the fuel. That a pound of coal should, in our best engines, produce an effect equal to raising a weight of a million pounds a foot high, is a result which bears the character of the marvellous, and seems to defy all further improvement. Yet the investigations of recent years have demonstrated the fact that the mechanical energy resident in a pound of coal, and liberated by its combustion, is capable of raising to the same height ten times that weight. But although the power of our most economical steam-engines has reached, or perhaps somewhat exceeded, the limit of a million pounds raised a foot high per lb. of coal, yet, if we take the average effect obtained from steam-engines of the various constructions now in use, we shall not be justified in assuming it at more than one-third of that amount. It follows, therefore, that the average quantity of coal which we expend in realising a given effect by means of the steam-engine is about thirty times greater than would be requisite with an absolutely perfect heat-engine.

Bones in Drift.—Sir Charles Lyell, in his last work, suggests that parts of the north of Europe had a climate of intense cold at the time of the supposed co-existence of several extinct quadrupeds with man (the maker of the much-discussed flint implements found in the valley of the Somme and elsewhere). Presuming that to have been the case, may not the same circumstances have prevailed as now occur in Siberia, where numerous extinct animals are perfectly preserved in the stratum of ice which covers parts of that country, and which probably, with its contents, is a remnant of our tertiary period? This ancient stratum of ice is in summer undergoing a constant process of destruction by thawing; and thus the animals imbedded in it are liberated, and their fleshy parts decaying, the bones remain on the surface of the land, or fall to the bottom of the river channels, and, with gravel and mud, must necessarily become so mixed up with the remains of man and of his works, as well as with the bones of other animals now living in that country, that it would, I believe, be impossible for the most skilful observer, after the disappearance of the ice, to declare, either from their state of preservation or from their relative position, that they were not the remains of man and quadrupeds which must have been contemporaneous inhabitants of the land,—leading to the same fallacies which may be observed in some of the conclusions which have of late been too hastily drawn regarding the human remains found in the drift in connection with those of animals, the species of which were probably extinct long before the appearance of man upon the scene.—*Athenæum*.

Illuminating power of the Electric Light.—The following is a short notice of Observations made by Professor W. B. Rogers on the Illuminating Power of one of the large batteries used by Mr Ritchie of Boston, United States, in the recent grand exhibitions of the Electric Light in that city:—"The battery in question, consisting of 250 Bunsen

pairs of the largest size commonly used, was arranged in the dome of the State House, and the carbon light and the photometric apparatus prepared for the purpose were placed in line across the same apartment, commanding a range of about 50 feet. In view of the immense power of the light as observed in the previous experiment, I substituted for the 20-candle gas-burner, used at that time as the standard of comparison, a unit ten times as great, formed by the flame of a Kerosene lamp placed in the focus of a small parabolic reflector, and throwing its concentrated light on a photometric screen of prepared paper fixed in front of it, at the distance of five feet. Before the observation the lamp and reflector were so adjusted as to make the light cast on the near side of the screen equivalent by measure to the action of 200 candles. A platform supporting the standard lamp and screen at the assigned distance was arranged to slide on a horizontal graduated bar, extending directly towards the carbon point, so that the screen should receive the rays from the electric light, and from the reflector perpendicularly on its opposite faces. In making the observations, the platform was moved to and fro until the illumination on the opposite sides of the screen was judged to be equal, and then the measured distances of the two antagonising lights from the screen gave by easy computation their relative illuminating power. By a series of such observations it was found that the carbon light had a force varying from 52 to 61 times that of the lamp with reflector, making it equivalent in illuminating power to the action of from 10,000 to 12,000 standard sperm candles pouring their light from the same distance upon the surface of the screen. This it will be remembered is the effect of the unaided carbon-light sending its rays equally in all directions from the luminous centre, and falls vastly short of the illuminating force of the cone of collected rays which was seen stretching like the tail of a comet from the surface of the great reflector. Judging from some recent experiments on the power of such a reflector to augment the intensity of the light emanating from its focus, there can be no doubt that along the axes of the cone when brought to its narrowest limits—the illuminating force of the carbon light as displayed on the State House could be rivalled only by that of several millions of candles shining unitedly along the same line.”

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1. Sur la Statistique Générale des Différents Pays. Par M. Ad. Quetelet.—*From the Author.*

2. Annuaire de l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique, 1862–63.—*From the Academy.*

3. Bulletin de l'Académie Royale des Sciences, des Lettres, et des Beaux Arts de Belgique, 30^{me} Année, 2^{de} Serie, tom. XI. et XII., 1861; 32^{de} Année, 2^{de} Serie, tom. XV., Parts 1–6, et 32^{de} Année, 2^{de} Serie, tom. XVI., Part 7, 1863.—*From the same.*

4. Proceedings of the Literary and Philosophical Society of Manchester. Nos. 11 and 12, Session 1862–63.—*From the Society.*

5. Proceedings of the Academy of Natural Sciences of Philadelphia, Nos. 7–12, for 1862; Nos. 1 and 2, for 1863.—*From the Academy.*

6. Journal of the Academy of Natural Sciences of Philadelphia. New Series, Vol. V., Parts 2 and 3.—*From the same.*

7. Journal of the Chemical Society. 2d Series, Vol. I., Nos. 3-5, and No. 9, for 1863.—*From the Society.*

8. Journal of the Asiatic Society of Bengal, No. 5, for 1862, and No. 2, for 1863.—*From the Society.*

9. Memoirs of the Geological Survey of India. 2d Series, Part 3.—*From J. Oldham, Esq., Superintendent of the Survey.*

10. American Journal of Science and Arts for March, 1863.—*From the Editors.*

11. Transactions of the Manchester Geological Society. Vol. IV., No. 5, Session 1862-63.—*From the Society.*

12. A New Theory of Muscular Action. By the Rev. Samuel Houghton, M.D., F.R.S.—*From the Author.*

13. Report of the Proceedings of an International Congress on the Subject of Cruelty to Animals, and especially Vivisection.—*From the Society for the Prevention of Cruelty to Animals.*

14. Holmes' Magneto-Electric Light as applicable to Lighthouses.—*From the Proprietors.*

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16. The Analogy of Thought and Nature. By E. VANSITTART NEALE, —*From the Publishers.*

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20. Report of the Superintendent of the United States Coast Survey, for the years 1859 and 1860. 2 Vols.—*From the Smithsonian Institution.*

21. Catalogue of the Army Medical Museum, Washington, D.C.—*From the same.*

22. Annual Report of the Board of Regents of the Smithsonian Institution.—*From the same.*

23. Canadian Naturalist and Geologist, Nos. 1-3 (February, April, June), for 1863.

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